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THE INSTITUTION OF CIVIL ENGINEERS.

THE rebuilding of the greater part of the house of the Institution of Civil Engineers in Great George street, Westminster, London, affords a fitting occasion for a glance at the history of the representative institution of British engineering. For our engraving and the particulars here given, we are indebted to the Engineer, London. The theater of 25, Great George street, is not to be wholly rebuilt, and is in present use for the meetings of the institution, and for those of the several societies accustomed to meet there with the permission of the council. All the other parts of the house are, however, demolished, and the institution library, reading room, and offices have, for the year or so the building will occupy, been transferred to No. 9 Great George street.

The present is the sixty-seventh session of the institution, and it is fifty-nine years since its existence was first announced to the world by the publication of its proceedings. The honor of having originated the institution is often assigned to Smeaton or to Telford, but, as is told in a historical notice of the institution and its proceedings, published with the Report of the Council in 1886, the idea is erroneous in both cases. Smeaton died many years before it was thought of, and Telford only joined it after its establishment. A Society of Engineers, still existing, was founded by Smeaton in 1771; it is generally known as the "Smeatonians," and includes many of the most eminent members of the profession, but it is rather of the nature of a social club than a scientific association, and has no connection with the institution. It was, indeed, of too exclusive a nature to meet the wants of so large and mixed a body as soon became engaged in engineering; and early in the present century a feeling began to be entertained that an institution on a larger scale, having for its object the furtherance of professional knowledge, might be made eminently useful. The persons who took the initiative in the matter were six young men, then beginning their engineering life — William Maudslay, Joshua Field, Henry Robinson Palmer, James Jones, Charles Collinge and James Ashwell. Toward the end of the year 1817 they, impressed with the difficulties of gaining the knowledge necessary for the diversified practice of engineering, resolved to form a society for promoting regular intercourse between persons engaged in the profession, to the end that such persons might mutually benefit by the interchange of individual observation and experience. The first formal meeting was held at the Kendal Coffee House, Fleet street, on January 2, 1818. The proposal was favorably received, the society was established, other engineers joined, and rules were framed for its government. During two years it continued to meet, and the result of its experience of the value of the meetings was such as to warrant an effort being made to extend the limits of the society. It was perceived that a principal step toward this extension would be to obtain the direct patronage of some eminent and popular professional man. Accordingly, on January 28, 1820, the following resolution was passed:

"That in order to give effect to the principle of the institution, and to render its advantages more general both to the members and the country at large, it is expedient to extend its provisions by the election of a president, whose extensive practice as a civil engineer has gained him the first rate celebrity; . . .

THE INSTITUTION OF CIVIL ENGINEERS, WESTMINSTER, LONDON.

MR. CHARLES BARRY, F.R.I.B.A., ARCHITECT.

and that a respectful communication be made to Thomas Telford, Esq., Civil Engineer, requesting him to patronize this institution by taking upon himself the office of president."

So little was the society known up to this time, that Telford had never heard of it when the foregoing resolution was announced to him; but appreciating, with characteristic judgment, the value of such an institution, and the useful results it was capable of yielding, he accepted the proffered chair without hesitation, and was formally installed on March 21 following. Telford's name gave an impulse to the progress of the society, which grew rapidly in importance under his fostering care, until on June 3, 1828, it received a Charter of Incorporation under the Great Seal, by the title of the Institution of Civil Engineers. Telford died on September 2, 1834.

In 1836 the first volume of the "Transactions" was published. It was a handsome quarto of 325 pages, illustrated by twenty-eight elaborate engraved plates, and it contained twenty-eight selected communications, for the most part of high character, and written by men of considerable eminence.

In the report of 1837—the first published—the council dwelt with satisfaction on the increasing success of the institution, and expressed a hope that the profession generally would unite in advancing the objects which the original projectors had in view.

In the year 1879, Dr.—afterward Sir William—Siemens, member of council, offered a sum of £10,000 to form the nucleus of a fund for providing a suitable building wherein the applied science societies might be assembled under one roof. This munificent offer called forth warm expressions of gratitude; but the difficulties in carrying out such a comprehensive scheme, and at the same time of preserving the individuality and the property of each society, were so great that the idea had to be abandoned. It had, however, long before been pointed out, and was still fully acknowledged, that there would be great advantage in bringing the many societies formed for the study of various branches of engineering into closer union with this the parent institution.

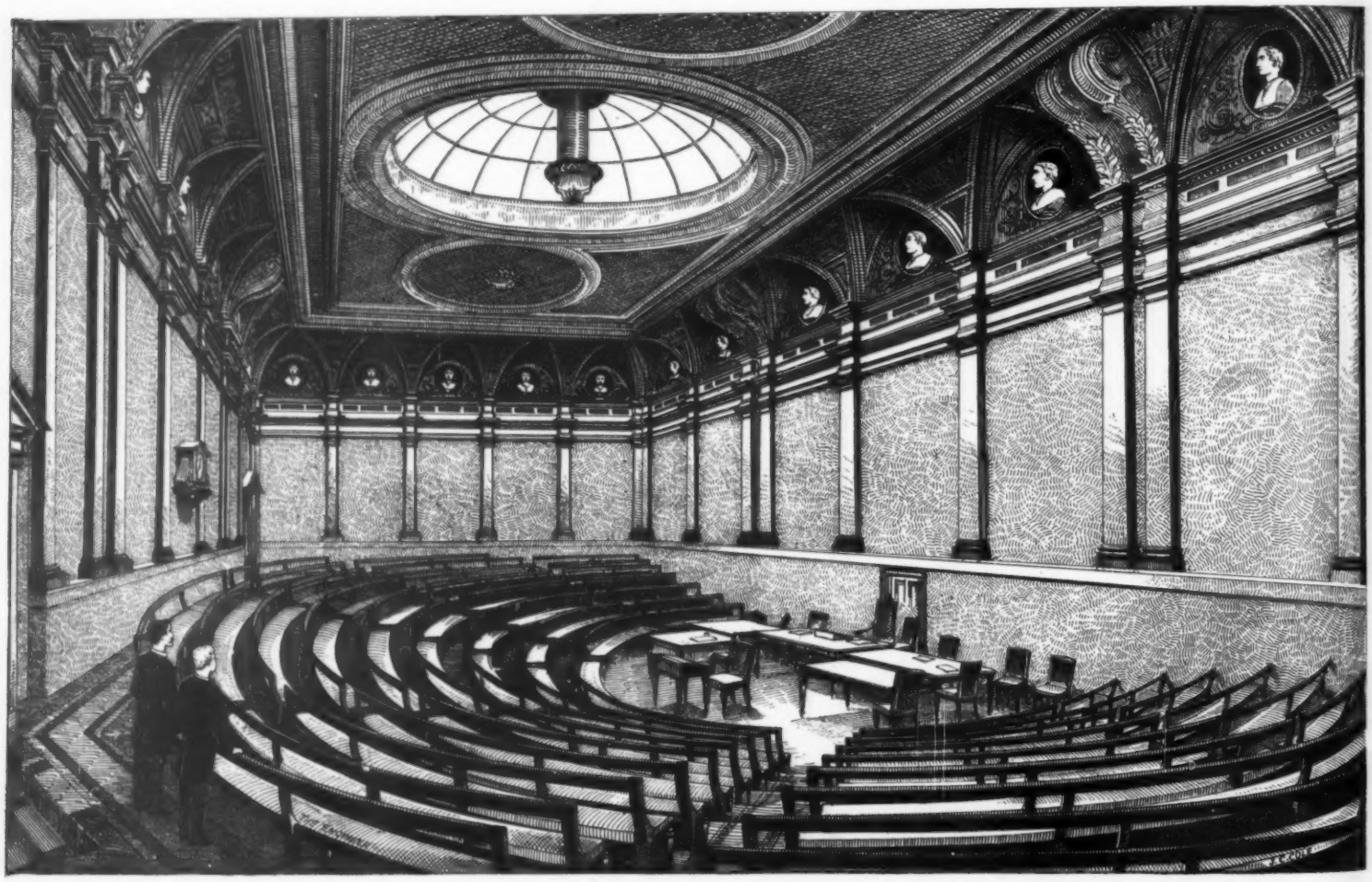
Having now glanced at the steps by which the institution has arrived at its present position, it may be desirable to give some account of its constitution, of the objects for which it was established, and of the way in which those objects are sought to be carried out. The persons for whose benefit the society has been formed are defined by its chartered title, "The Institution of Civil Engineers." As the exact meaning of the words "civil engineers" is very important, and has given rise to much discussion, the council in 1866 defined the term as understood by the institution. The charter states "the profession of a civil engineer" to be "The art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange, and in the construction of ports, harbors, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns." But it was pointed out by Thomas Tredgold, who drew up the "Description of a Civil Engineer," partly embodied in the charter, that "the scope and utility of civil engineering will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical science." Consequently, since the charter was drawn, the range of practice of the profession has become much enlarged.

There is reason to believe that Smeaton was the first civil constructor of large public works who called himself an engineer, and who used accordingly the distinguishing compound title. The term "civil engineer" means, therefore, an engineer who is a civilian, as distinguished from a military engineer. The Institution of Civil Engineers is intended to include all classes of engineers who do not belong to the military service.

The present theater is a handsome meeting room, 60 ft. long by 40 ft. wide, and 30 ft. high, which will accommodate 450 persons. Below this there were reading and writing rooms—where all English and foreign periodicals likely to be interesting to the members will be found—and a council room. The front of the house was chiefly devoted to the library and to the offices of the staff.

Although the meeting room is large enough except on extraordinary occasions, this could not be said of most of the other parts, especially the library. The library is a feature of which the members have just reason to be proud. Originating with a present of books from Telford, on his accepting the presidency, it contained in 1851, when a catalogue was first published, 3,000 volumes and 1,500 tracts. Fifteen years later, a second edition was issued, and the numbers then were 5,500 volumes and 3 200 tracts. In 1873 it was ascertained by actual enumeration that the number of volumes was 10,443, including 320 volumes of tracts and at the present time it consists of about 50,000 volumes, occupying 2,238 lineal feet of shelves.

The new building is to be as far as possible of fireproof construction. There is no doubt that when completed the institution will be very handsomely and commodiously housed, and it is hoped that the building will be completed by the end of this year.



THE THEATER OF THE INSTITUTION OF CIVIL ENGINEERS, LONDON.

[FROM THE ENGINEER.]

THE SIMPLON TUNNEL.—II.*

(7) EXECUTION of Work: System of Construction.—In all previous projects for the construction of a tunnel under the Simplon, great difficulties were foreseen on account of the subterranean heat. The method by which Messrs. Brandt, Brandau & Co. propose to construct it is quite new; instead of making a single tunnel for two lines of rails, two headings will be driven simultaneously, their centers being 56 ft. apart. Every 220 yards these two headings will be joined by transverse passages. Of the two headings, No I will be opened out to the full section as the work advances, but tunnel II will only be finished if the traffic develops sufficiently to require a continuous double line of rails, instead of the passing place that has been arranged in the center. Gallery II will have a sectional area of 86 square feet. It will serve as a ventilating passage, as the cross galleries will be closed by doors, excepting the last two, so that the air which will be forced into heading II. by powerful fans will cross through them into heading I, and pass through all the workings, before it goes out at the entrance of tunnel I. The water mains will also be laid down in heading II. In working, the empty trucks will enter by this heading and the loaded ones will pass out through No. I. There will be the further advantage that No. II can also be used for the trains going out, in case of necessity.

In constructing tunnel I, the advance heading will be made on the base, shafts raised from time to time to the roof, and headings from these driven both ways. Finally, the tunnel will be enlarged to the full size in the usual manner, and finished. Tunnel II can be finished without interfering with the work of No. I. As long as No. I only is being used, it can be repaired with no more difficulty than there would be for an ordinary tunnel 220 yards long; as workmen and material could come in by heading II and pass through the nearest transverse gallery to the place where the repairs were required. In case of any serious breakdown in the masonry, No. II would be still more useful, as from it drifts could be run to come behind the damaged part.

(8) Mechanical Perforation in Headings.—Headings I and II will be started simultaneously, with three or four Brandt's rotary hydraulic drilling machines working at each face, the motive power being furnished by two 4 in. mains. For the first half of the north end, while going through schist, it is proposed to use a pressure of 1,000 lb. per square inch; but, for the second half, and for all the south end, where gneiss has to be penetrated, the pressure will be 1,500 lb. Besides the six or eight machines in these headings, there will be four on each side for the upper headings and the cross galleries. These twelve machines will use four gallons of water per second at a pressure of 1,000 lb. or 1,500 lb. In hard rock, twelve to fifteen holes 2¾ in. diameter, and about 49 in. deep, will be needed in schist, eight to ten holes of the same diameter, and about 55 in. deep. Two months after work is commenced the rock drills can be started, using steam as motive power, both at the north and south ends. Ten months later the turbines will be at work, and the drilling will be able to advance more rapidly. It is estimated that during the two months of hand drilling, about 66 lineal yards will be excavated at each end; during the ten succeeding months, at five yards a day, 1,500 yards on each face. Supposing that five months are required to open out and finish, after the headings from the opposite ends meet, a daily average progress of nearly 6½ yards will be required during the remaining forty-nine months.

The report then gives details of perforations made by Messrs. Brandt & Brandau at the Arlberg Tunnel, at the Mansfelder Kupferschieferbauende Gewerkschaft, and at the Suram Tunnel in the Caucasus through hard rock; in all of which the rate of progress has exceeded that specified. At Simplon the greater part of the tunnel will be through gneiss. Accordingly a block of Antigorio gneiss was taken to Winterthur in 1891, to be tested with one of Messrs. Brandt's machines, and it was found that it took from twelve to twenty-five minutes to drill a 2¾ in. hole 40 in. deep. At the slower of these two rates, four machines could drill fifteen holes 49 in. deep in two hours and five minutes; so that there ought to be no difficulty in keeping up the required speed through gneiss; while the progress should be much more rapid through schist

* Continued from SUPPLEMENT, No. 998, page 15948.

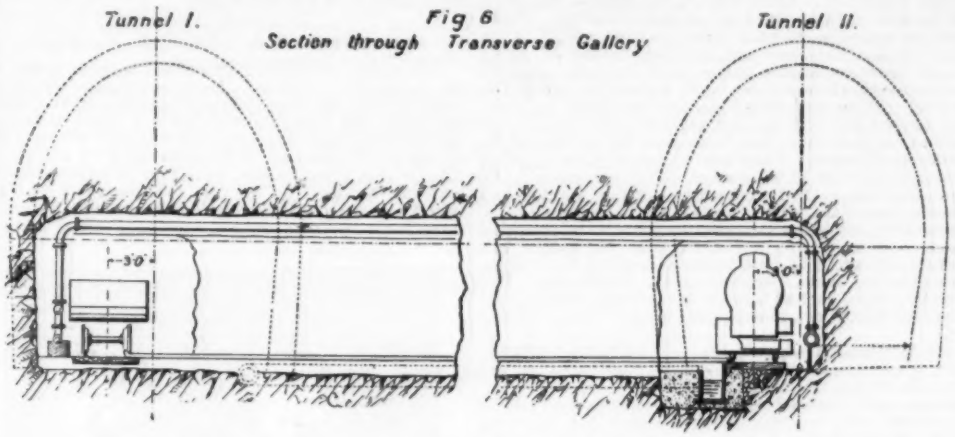
(9) Clearing Away the Rubbish.—The continual improvements in rock drills have considerably reduced the time required for perforation, while more powerful explosives have increased the progress made by each attack. But the time required for clearing away has remained unaltered, and is, therefore, relatively of much greater importance than it was formerly. Though various plans have been tried for doing this work more quickly, nothing has been found better than loading up by hand, direct into the trucks in which it is to be removed. The difficulty at present is that the pieces only fall just in front of the face, on the spot where the machines will have to stand. If they could be thrown much further, they could be quickly pushed to the right and left, and afterward removed, while the next set of holes were being drilled. This the contractors have found a way of doing by hydraulic means, as they have proved by satisfactory experiments. Besides saving time, the employment of this system cools both the workings and the broken rock very considerably.

(10) Upper Headings, Opening Out, and Lining.—The shafts and the upper headings in tunnel I will be commenced in each 220 yards section, as soon as the cross gallery at the head of this section has been opened, and the current of air has begun to pass through it. According to the nature of the rock, hand or machine drilling will be employed in these upper headings. As soon as one upper heading reaches the next, the full section will be opened out, and the masonry will follow at once.

(11) Ventilating and Cooling the Works.—The essential principle in the ventilation has already been explained to be the introduction of a large quantity of air into heading II, which passes through the last two cross galleries into tunnel I, from which it escapes into the open air. This is not only intended to supply the workmen with pure air, but also to cool the rock. The quantity of air required for the first of these purposes is relatively small. In the Gothard, from 50 to 70 cubic feet of air was introduced per ought to cool the rock to such an extent that no other cooling arrangement should be required, either in the headings or by the masons. But if it should be too hot in summer, its temperature can easily be lowered 20 deg. or 30 deg. by means of water sprays when passing through the transverse galleries.

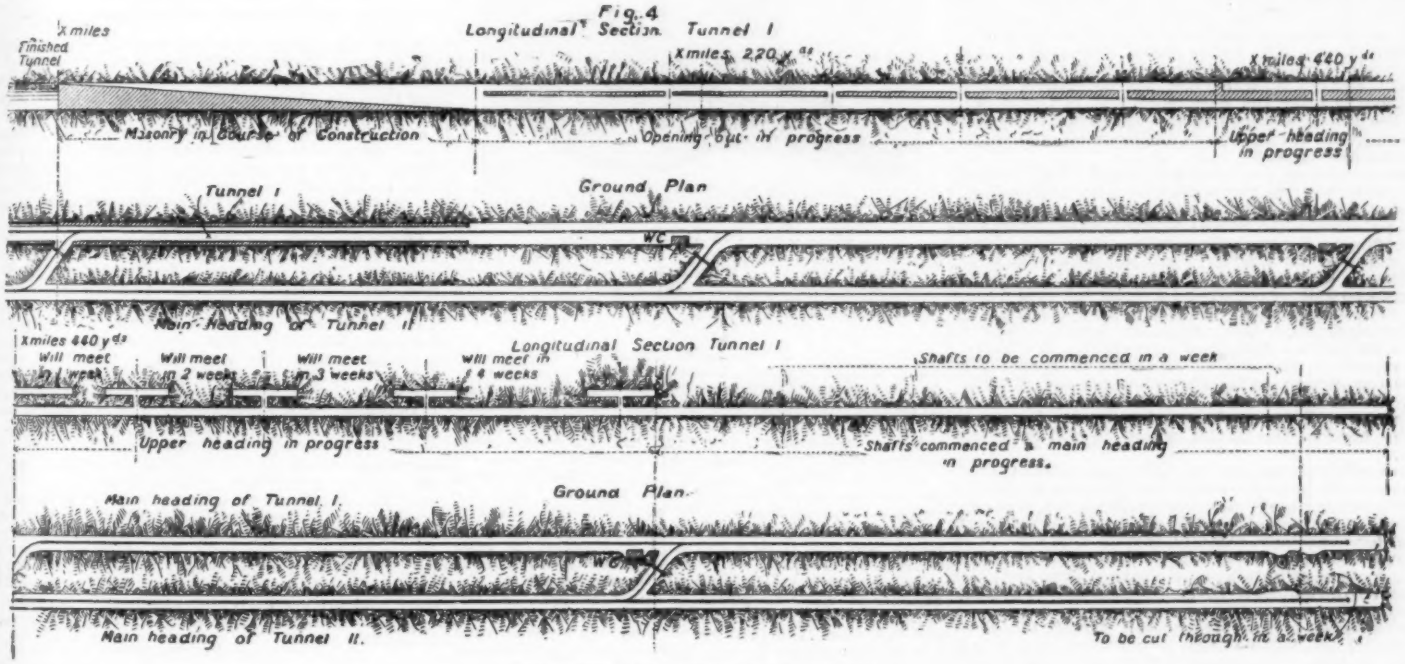
For the advance headings in I and II, 12 or 13 cubic feet of air for each working face will be taken from the last cross gallery, and by means of hydraulic injectors cooled to 45 deg. or 50 deg. Fah., and forced through a small line of pipes to the front. Similar hydraulic injectors in heading I will supply from 7 to 14 cubic

Fig 6
Section through Transverse Gallery



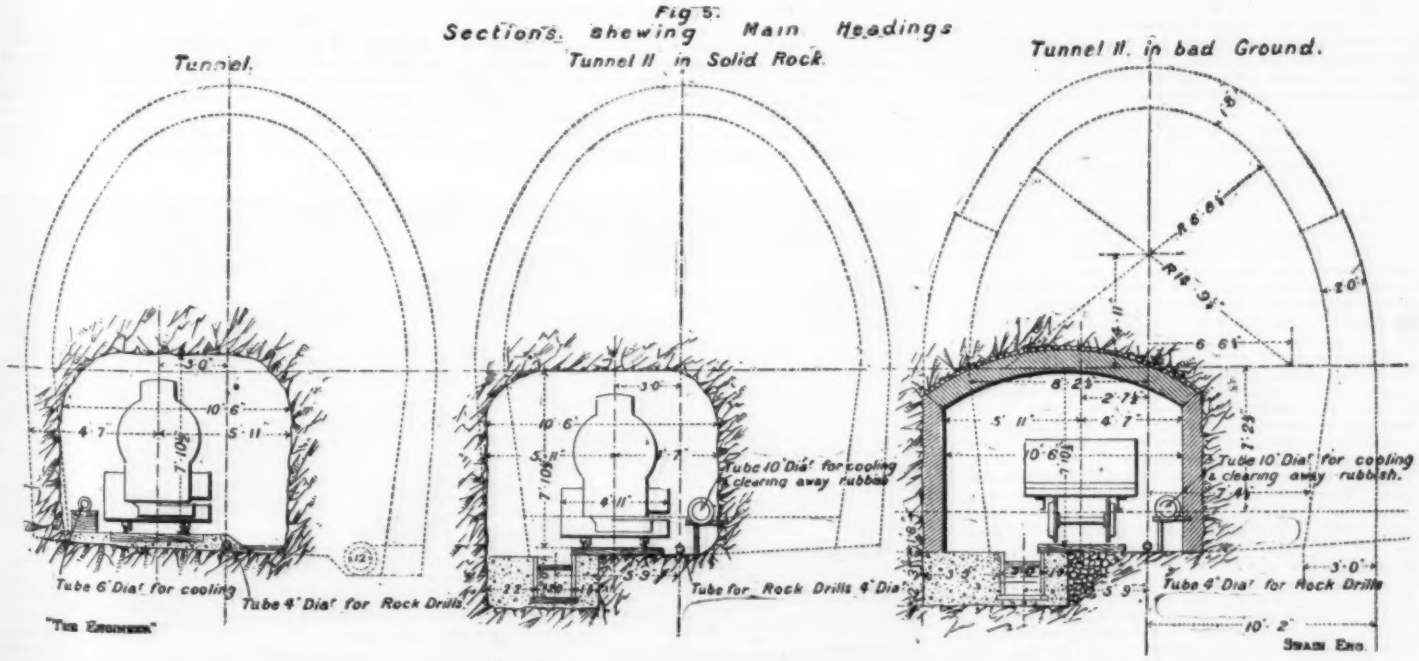
To drive 1,750 cubic feet of air through a heading six miles long, and 86 square feet in sectional area, a pressure equal to 18¼ in. of water will be required, to which must be added another inch for the resistance in the heading and in tunnel I, making a total of 19¼ in. If the effective work of the fans be taken at 65 per cent., a force of 500 horse power will be required to supply 1,750 cubic feet of air per second, at a pressfeet of air per second to each working face in the upper headings. Besides these air pipes, there will be in each of the upper headings branches from the cold water main, so as to cool the walls and the broken stone. After allowing for the cooling power of the air, it is calculated that 11 gallons of water at a temperature of 54 deg. will be required per second to bring the temperature of the walls down to 68 deg.

Fig. 4
Longitudinal Section Tunnel I


X miles
Finished Tunnel
X miles 220 yds
X miles 440 yds
Masonry in course of Construction
Opening out in progress
Upper heading in progress
Tunnel I
Ground Plan
WC
Main heading of Tunnel II
X miles 440 yds
Will meet in 1 week
Will meet in 2 weeks
Will meet in 3 weeks
Will meet in 4 weeks
Longitudinal Section Tunnel I
Shafts to be commenced in a week
Upper heading in progress
Shafts commenced & main heading in progress.
Main heading of Tunnel I.
Ground Plan
WC
Main heading of Tunnel II.
To be cut through in a week.

SECTIONS OF SIMPLON TUNNEL.

Fig 5.
Sections shewing Main Headings


Tunnel.
Tunnel II in Solid Rock.
Tunnel II. in bad Ground.
Tube 6' Dia' for cooling
Tube 4' Dia' for Rock Drills
Tube 10' Dia' for cooling & clearing away rubbish
Tube for Rock Drills 4' Dia'
Tube 10' Dia' for cooling & clearing away rubbish.
Tube 4' Dia' for Rock Drills
"The Engineer"
Swain Eng.

second. At Arlberg, for a long time, 100 ft. was considered sufficient; toward the end of the work, when the number of men was greatly augmented, this was increased to 200 ft., which was found ample. At Simplon there will be a maximum of 1,750 cubic feet per second, which will pass through heading II at a velocity of about 20 ft. per second. This quantity of air sure of 19½ in. water. Two fans 18 ft. diameter will be put up at each end of the tunnel, and coupled directly to the turbines. These fans will be so arranged that, coupled one behind the other, they can either aspire or force 1,750 cubic feet of air at a pressure of 19½ in., or coupled side by side they can pass 3,500 cubic feet air at a pressure of 9¾ in.

About 18 gallons per second will be provided for this purpose. It is, therefore, anticipated that even if the works are impeded by the internal heat being a few degrees greater than the geologists predict, they will not be altogether stopped.

The cooling water main, which will have a diameter of about 10 in., will be placed in heading II, and as the

work advances, branches will be taken through the transverse galleries. The water from this main will be used for clearing away the broken rock, as well as for cooling. But it will only be applied to this purpose for a minute or two after each attack, and at the most once in two hours, so that its temporary stoppage in the upper headings will not be of any consequence.

(12) Transport.—Lines 2 ft. 7⅛ in. gauge, and with 40 lb. rails, will be put down in each heading. There will be branches at each cross gallery, and it is for this reason that they are oblique, instead of being made at right angles to the main tunnels. Special steam locomotives will be built for service inside the tunnel. They will weigh sixteen tons when in working order, and will be constructed with extra large boilers, so that there may be no need for stoking while inside the tunnels. They are to be capable of going round a curve of 50 ft. radius. The trucks are to be on metal frames, and are to have springs, buffers and elastic draw bars. They must have a capacity of 70 cubic feet, and seats for three men are to be provided back and front. As a general rule, the trains will enter by heading II, and leave by heading I, so as to travel in the same direction as the ventilation. The trucks will be backed into the transverse galleries, and the fans will be run more slowly while a train is going up.

(13) Hygienic Arrangements.—Dressing rooms, baths, etc., are to be provided as near as possible to the entrances of the tunnels, to which they are to be connected with covered ways. Each workman will be provided with working clothes, which will be dried and cleaned after each shift. The report also describes the sanitary arrangements inside the tunnel.

(14) Outside Erections. North Side.—These buildings are on the left bank of the Rhone, and are so arranged that they can be used while tunnel II is being finished without interfering with the work of tunnel I. The work at the north end may be divided into three periods. The first of these is the first twelve months of construction, before the water conduits from the Rhone, and the turbines, etc., have been finished. During this time 170 horse power will be required; of this 140 horse power will be for six rock drills and 30 horse power for working small hydraulic ventilators, and also for a small workshop. This power will be provided by three 60 horse power semi-portable engines, of which one will be started about two months after the commencement of the works, and the others within the two subsequent months. These engines will be kept as a reserve till the termination of the work.

The second period will last a year and a half, or two years, until the first three miles have been completed. During the first and second periods an 8 in. bore hole is to be put down near Berisal, which is to penetrate the tunnel three miles from the mouth. The depth of this hole will be about 2,300 ft. From the Steinenbach, at an altitude of 5,900 ft., a quantity of water equal to twenty-two gallons per second will be taken and conveyed in pipes, carefully protected from the frost, to this bore hole, and down it to the tunnel, where it can be utilized for drilling or for cooling. It will give a pressure at the drilling machines of about 1,500 lb. to the square inch. If, contrary to all expectation, the bore hole should not be made successfully, this water will be conducted by a special conduit to the head of the tunnel, where it will enter the main.

During this second period, 750 horse power will be required; 200 horse power for eight rock drills, 250 horse power for the ventilating fan, 200 horse power for internal and external electric lighting, and 100 horse power for workshops, saw mill, mortar mill, etc. It is not expected that cooling water will be required before the end of the third mile, as it is only then that the distance from tunnel to surface commences to become considerable.

The duration of the third period, from the third to the sixth mile, will be from two to two and a half years. In this, it is estimated that 500 horse power will be required for ventilation, 200 horse power for electric lighting, and 100 horse power for workshops; this power will be taken from the Rhone. The supply of five gallons of water per second for the rock drills and of thirteen gallons per second for cooling, or for clearing away the broken rock, will be furnished by the Steinenbach, which will come into the tunnel, as described above, at a pressure of 1,500 lb. per square inch.

South Side.—It was not easy to find a suitable site for the necessary buildings on this side, as the valley is narrow and descends rapidly. The baths, laundry and dressing rooms are on the right bank of the Diveria, and are connected by a covered gallery with the heading. Two bridges will be made over the Diveria; trains entering or leaving the tunnel will cross the upper bridge, while the lower one communicates with the dressing rooms, etc.

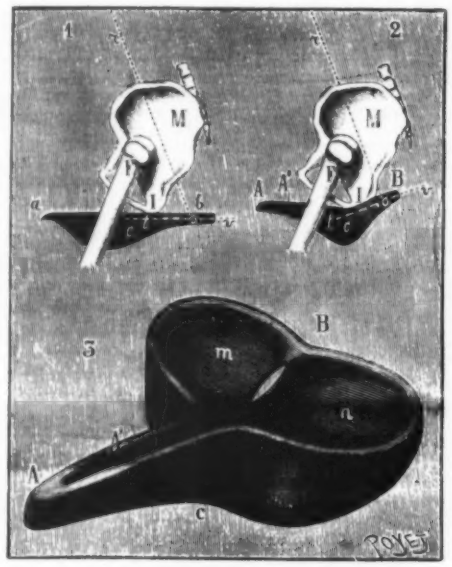
The power house, workshops, stores and offices are to be on the left bank of the Diveria, but at two different levels, one 17 ft. above the other. The machinery will be on the upper level, while wood, stone, sand, lime, etc., will be stowed on the lower; the offices and stores will be placed between them. In deciding the position of these buildings there were two considerations—first, that it should be possible to finish tunnel II without interfering with the traffic of tunnel I; and secondly, to impede the circulation on the road as little as possible during construction.

At the southern end, the work is divided into two periods. The first period is, as at the northern end, the first year of construction, until the turbines are in working order. The power needed will be 180 horse power for six rock drills working at 1,500 lb. pressure, and 30 horse power for the small ventilators and small workshops. Three portable engines, each of 75 horse power, will supply this. As on the north side, one of these will be in use two months after the works are commenced, and they will be retained as reserve force till the completion of the works. The second period will last for four or four and a half years, till the six miles from the southern end are finished. The motive power needed will be 1,700 horse power, divided as follows: For ten drilling machines, 350 horse power; for cooling and hydraulic clearing, thirteen gallons per second at a pressure of about 750 lb. per square inch, 550 horse power; ventilation, 500 horse power; electric lighting, 200 horse power; and workshops with saw mill, mortar mill, concrete mixer, etc., 100 horse power.

Besides hotel, canteen and dwellings for workmen and overseers at Iselle a hospital is to be erected at Rosso, near Varzo; and houses for the engineers will be constructed as they may be required. The large ventilating fans will be placed close to the entrance of the tunnel as at the north end.

AN IMPROVED BICYCLE SADDLE.

THE saddle, of all the parts of the bicycle, is the one that is still in its infancy. In the mechanics in general of the bicycle, at present so well elaborated, the saddle has remained rudimentary. It is a piece of leather stretched over springs, almost at hazard. To write it is to express the opinion of the generality of wheelmen, all of whom, more or less, have had to suffer from its bad construction. In the rare indispositions that the bicycle is capable of occasioning, the saddle is to blame three times out of four, and accidents to the perineal



THE SAR BICYCLE SADDLE.

1. Diagram showing the position of the bones of the pelvis upon an ordinary saddle (M, iliac bone; I, ischion; F, femur). 2. Diagram showing the position upon a Sar saddle. 3. The Sar saddle (M, the front plate; B, the cantle; C, re-entrant part for the free passage of the thigh; m and n, cavities for the ischions).

organs, in male as well as in female cyclists, have become almost the only mishaps that are still to be dreaded. There is nothing here that prejudices the high hygienic character of cycling recognized and installed by medical authorities, but simply an indication of the extreme importance that a study and a common sense construction of the saddle has in this sport.

Apropos of this, it may be asserted that the worst saddles are those that are most suspended and the softest. The rider sits as if fitted into them, and rests almost exclusively upon the perineal organs. We shall speak here only from a hygienic standpoint, for from a mechanical one it will be understood that such a seat is the cause of a great waste of strength at the expense of the propulsion of the machine. As the springs are compressed under the weight of the rider, the first work that the leg produces in bearing upon the pedal consists in easing these springs by elevating the body, and not in actuating the machine. Upon the track, where it is indispensable that the racer shall not waste his strength, the saddles have no spring. But it is evident that the form of the saddle is much more important than is its suspension.

A cyclist of long experience, Mr. Pansard, aided by the judicious advice of Dr. Hammonic, has just got up a saddle, the trade mark of which is a pea fowl and the name "Sar" saddle, and which offers better than a play on words the indisputable advantage of at length forming a common sense bicycle seat.

Every cyclist rests upon the saddle (Fig. 1) through the two lower parts of the iliac bones, M, called the ischions, I. While his femur, F, works in actuating the machine, his body takes the inclined position, r s. In the construction of the ordinary saddle that this figure represents, the front plate, a, and the cantel, b, are in the same horizontal plane. The result is that the ischions are displaced upon the even surface of the leather, that r s forms an acute angle, r s t, with t v, and that the rider insensibly approaches the front plate of the saddle, upon which he comes to be no longer seated, but literally astride of. Hence he no longer bears upon his natural sitting points, but upon the base of the abdomen. He endeavors indeed to push himself backward by bearing upon the handle bar, but he tires his wrists and falls back upon the front at the least jolt. Moreover, the part, c, is but slightly curved within, and every backward movement made by the thigh has the effect of aiding this incorrigible sliding of the body upon the front plate.

The Sar saddle (Figs. 2 and 3) happily remedies all such inconveniences. Its cantle, B, has an inclination such that the line of the body, r s, forms a right angle with t v. The ischions therefore take a fixed bearing point upon it that the special shaping of the leather to conform to the gluteal muscles and the two depressions, m and n, for the ischions much facilitate. The rider's seat is, so to speak, fitted into this saddle, and deviates neither to the front nor the rear at the most violent jolt. Moreover, the front plate, A, is hollowed out for its entire length, so that the perineal organs can bear upon a hard part at no moment, while the cheeks of the saddle are curved almost at right angles at C in order to permit of a free play to the thigh.

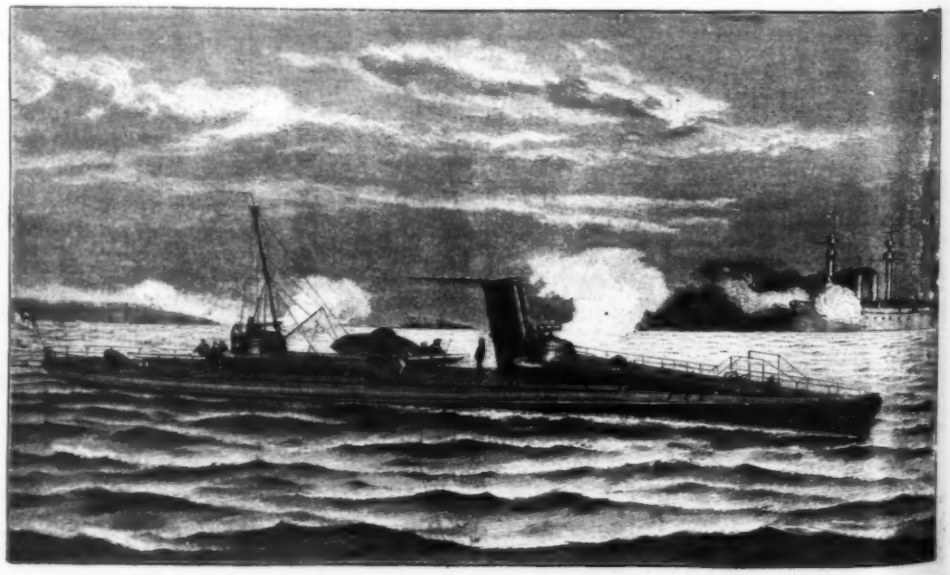
The result of these happy modifications is undoubtedly an increase of speed for the cyclist.

A large number of experiments made at different times have shown that the force that the rider lost upon an ordinary saddle in slidings and reinstatements, of which he was often even unconscious, are employed by him upon the Sar saddle in work upon the pedal crank.—La Nature.

A SCHICHAU TORPEDO BOAT.

MOST war vessels are now provided with torpedoes, but on account of their size they cannot approach the enemy near enough to use their weapons effectively, and therefore the use of special torpedo boats has become necessary. These are small, gray in color and have few noticeable objects on deck, so that they can steal upon the other vessels almost unobserved at night. They can send the torpedoes a distance of 1,000 feet to 1,300 feet, carrying destruction to any vessel that fails to light up the surface of the water about it by means of search lights.

Our illustration (for which we are indebted to the Illustrirte Zeitung) shows a torpedo boat that was constructed at the Schichau works in Elbing, and was sold, with four similar boats, to the Brazilian government. This boat is 151 feet long and has a displacement of 120 tons. The two engines, which together indicate 1,500 horse power, operate two screws, giving the boat a speed of 26 knots per hour. Like most of these boats, it is provided at the bow with the so-called whaleback deck, under which are the quarters of the crew. The devices for controlling the vessel are arranged in two little towers, one forward and one aft, on the top of each of which a revolver is pivoted. Our engraving shows the crew busy amidships and aft with the torpedo projectors, which are arranged to turn on rails. Besides these, there are on the deck only the smokestack, the ventilator, the lights for the engine room and a small mast used for signaling purposes. One small boat is the only means of communication with the shore or other vessels, or of escape in case of accident. Although these boats are built of light steel, and are not high above the water line, they are quite seaworthy, as has been proved by their voyage to Brazil.



TORPEDO BOAT.—DRAWING BY H. PENNER.

COLD STORAGE AND COLD ROOMS FROM COMPRESSED AIR.

By G. D. HISCOX, M.E.

IN view of the largely increasing demand for the means of preserving food in the warmer sections of the United States, and in tropical climates, where ice cannot be obtained, or the cost is so great as to preclude its use, the use of compressed air as a constant cooling medium is one of the means at the command and control of every one who is able to place a small outlay

for a valuable boon to household comfort; and for the profit that may be realized from the power to preserve fruit, vegetables and meat for sale, or for the time and opportunity for shipment to a market.

There are large tracts of country in the southern section of the United States in which are situated plantations and farms, the owners and managers of which, having the financial means to supply comforts to life by the use of cold preserved food, who are entirely beyond the reach of ice, either natural or artificial, and to whom such wants may be supplied by the means of any small power such as a windmill, a waterfall or a gasoline engine, operating a pump for the compression of air. In Mexico, the Central American and South American states, the field for useful work by wind and water power alone for contributing to domestic comfort by the preservation of food is immense; where power from nature as through a windmill or waterwheel can be utilized. The distance need not be considered beyond the cost of a small pipe for conveying the compressed air, as a considerable length is needed to cool the air to its normal temperature which has been heated by the operation of compression; when by expansion to atmospheric pressure the same amount of heat may be eliminated from the expanding air as was accumulated by its compression, and from which a large cooling efficiency may be obtained.

The graphic diagram has been made to show at sight the cooling effect produced by the free expansion of dry air from various pressures and from the normal temperature of sixty degrees Fahrenheit. The conditions of air expansion for any natural temperature of the stored air may be found by simply adding the difference to the expansion column when normally above sixty degrees, or subtracting when below sixty degrees. Thus, in an atmospheric temperature of eighty degrees, the cold produced by expanding from twenty pounds pressure would be minus sixty-seven degrees instead of minus eighty-seven, as shown in the diagram. From thirty pounds pressure and ninety degrees atmospheric temperature, the cold air of expansion would be minus one hundred and eight degrees instead of minus one hundred and thirty-eight, as in the diagram; thus for any atmospheric condition of temperature and pressure, the theoretical condition of cold by expansion may be known by simple inspection of their several relations as shown in the diagram.

The diagram shows much that is interesting in regard to the general conditions and effect of air compression and expansion. It will be seen that the column of pressures on the right corresponds with the column of heat developed by compression on the left, while the upper or adiabatic curve shows the condition of temperature, pressure and volume at the moment of compression. The lower or isothermal line shows the shrinkage of the volume due to the cooling of air to its normal temperature.

The vertical dotted lines from the intersection of the isothermal line with the horizontal lines of pressure, meeting the atmospheric line, form the starting points for the curves of expansion extended on the same scale of temperature corresponding with the scale of compression.

The intersection of the dotted lines extended through the curved lines of expansion show also in a graphic way the fractional expansions from one stage of compression to another lower one as measured by the expansion scale at the left hand side. Thus a volume of air at 60 lb. pressure and 60° temperature, when expanded to 30 lb. pressure, its temperature will fall to the intersection of the extended dotted line of 30° with the 60 lb. curve, which measured on the expansion scale is —57°, and so on for any other pressures.

In applying the conditions of air expansion to the practical effects of refrigeration or the cooling of rooms for cold storage and preservation of food, a large departure from the theoretical figures for the degree of cold by air expansion must be made on the favorable side for success.

The absorption of heat from the walls of a cold room, the cooling of a large body of air in the room and of food products stored and the greater loss from frequent opening of a cold room for the removal and refilling, with the natural leakage of cold air around the doors, makes the margin of loss in cold air production a larger one than at first appears when brought into actual use.

The amount of specific heat contained in a given volume of air is about $\frac{1}{850}$ of the amount contained in the same volume of water for any number of degrees change of temperature at ordinary climatic temperatures, so that there is a large margin between the volume of cold air required to cool a room filled with air only and the volume required to cool a room filled with fruit, vegetables, milk, butter or meat containing from 50 to 90 per cent. of water and of which the solid parts also have a far higher specific heat than air.

This property of water-loaded food accounts for the time required to cool a loaded cold storage room over the time required for cooling an empty one, as well as the necessity for so packing the material of storage that the cold air can circulate freely and bring every part to the required temperature in the shortest possible time.

As to the work that compressed air will do in cooling rooms, there is a large marginal range in the quantity of free air required for a specific temperature, due to the conditions of temperature of the material to be cooled and the amount of compression in the air to be expanded for this duty.

Assuming, for example, a cold room for a farm or plantation of 1,000 cubic feet capacity, or say 12 feet square by 7 feet high, thoroughly insulated, with a double door at side for storing; a single or trap door with a small ventilator at top, with steps from the trap door for every-day use, and also lighted from the top. By this means a loss of cold air is prevented by its greater specific gravity holding it at the bottom. The room may be kept uniformly at 34 degrees Fah. in an outside temperature averaging 80 degrees. To cool such a room from 80 degrees to 34 degrees requires a loss of 46 degrees in a volume of 1,000 cubic feet of air, say 77 pounds, the specific heat of which is 0·2377 water = 1. Then $77 \times 0{\cdot}2377 = 18{\cdot}3$ heat units must be absorbed for every degree of change in temperature. Then $18{\cdot}3 \times 46$ degrees = 841 heat units must be abstracted to bring it to 34 degrees Fah., leaving out the cooling of the walls, which will be only a matter of time in the initial operation.

Assuming to use an air pressure of only 30 lb. per square inch, then in the graphic diagram, tracing the dotted line from the isothermal curve junction of 30 lb. and following its curve of expansion, we have —138 + 60 degrees to the atmospheric line = 198 degrees difference in temperature by expansion from 30 lb. pressure, or 198 heat units per lb. of air. Then $\frac{841}{198} = 4{\cdot}24$ lb. or 55½ cubic feet of free air at 30 lb. pressure will be required to cool the room to 34 degrees.

A compressor of 5 cubic feet per minute capacity, using less than one horse power will furnish enough air to reduce the temperature of the room from 80 degrees to 34 degrees in about fifteen minutes, and should then easily furnish cold air for absorption of heat from the material of storage and to supply the waste made necessary by ventilation and radiation with a constant work of less than a half horse power. This power comes within the scope of a cheap class of water wheels, water motors, and the smaller sizes of gasoline engines and windmills.

Where intermittent power must be used, as with windmills and power engines, a system of storage of compressed air may be used with perfect satisfaction as affording a constant flow of air into the cold room and also into a small refrigerator, which will be found a most useful adjunct for kitchen use and the cooling of drinking water.

The amount of pipe surface required for cooling compressed air to the normal temperature is a matter of much importance, as its delivery at the point of expansion, to be effective, must be at, or very near, the temperature of the outside atmosphere.

The method of keeping the air cooling pipe at the proper temperature fixes the amount of pipe surface to be provided.

For 30 lb. pressure, 15 square feet of cooling surface per cubic foot of free air used per minute is a fair proportion for an air-cooling coil exposed to a free circulation of the atmosphere and shaded from the sun's heat.

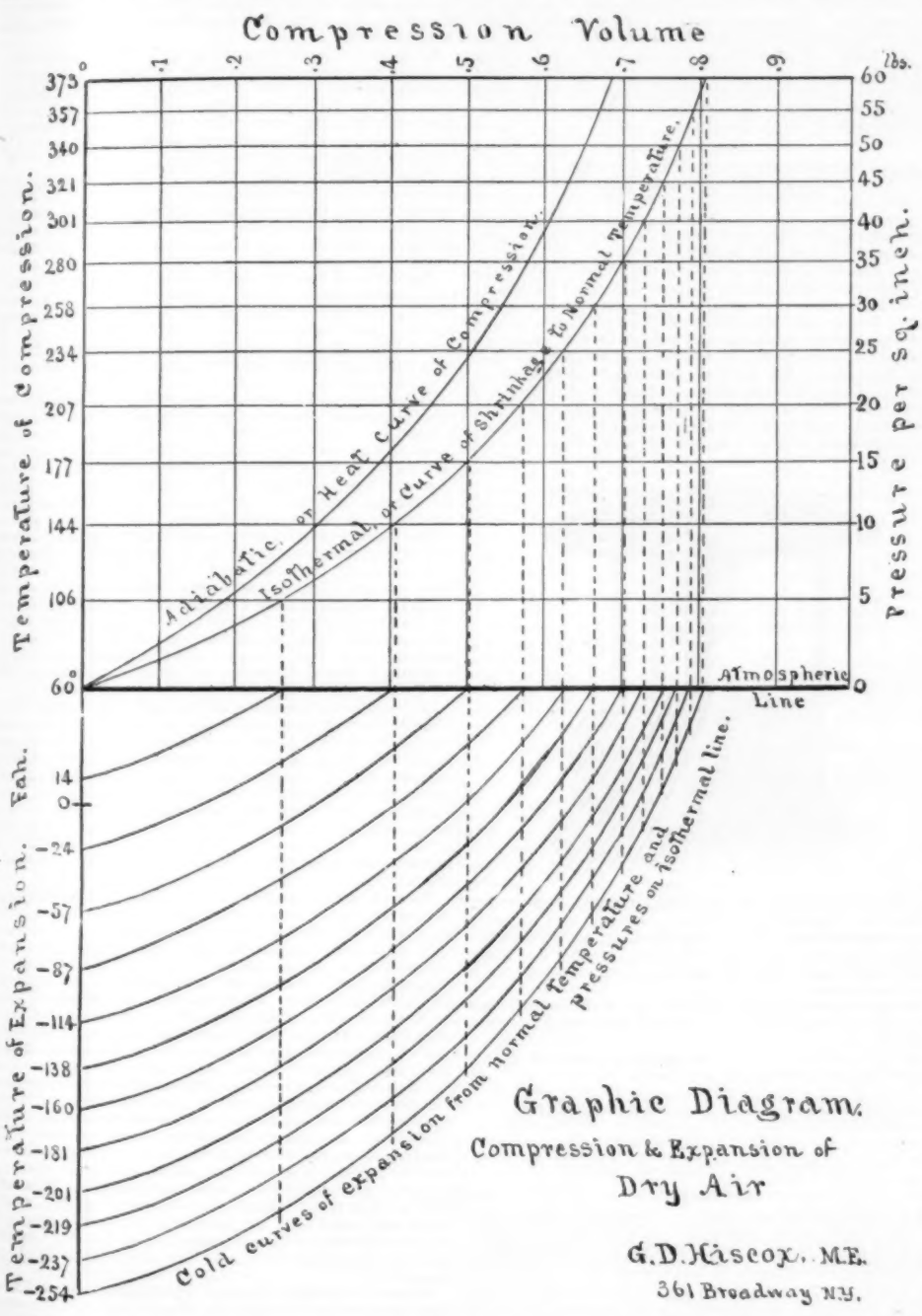
This would indicate a coil of 150 feet of 1½ inch pipe for the requirement of a cold room as above stated, which may also include the leading pipe from compressor to cold room, if favorably situated for cooling. Where it is convenient to use water for cooling, either by a sprinkler or by submerging the coil in a tank of water fed from a stream or by pumping, the size of the coil may be greatly reduced, according to the temperature of the water.

For an intermittent power as a windmill, or a gasoline engine that would not be convenient to run at night, a storage of air will be necessary by the use of a proportionally increased power during the day for accumulating compressed air in tanks.

The storage of sufficient air for a 10 hours run of the above plant will require tanks to hold about 1,200 cubic feet, or say 3 tanks of cylindrical form 5 feet diameter, 21 feet long. As the atmospheric temperature always falls at night in tropical and semi-tropical regions, the conditions of compressed air supply may be much modified in the storage quantity above outlined, and where constant power can be obtained, the whole question of cold storage for private use becomes a cheap and simple one.

The arrangement of the nozzle or orifice for delivering the compressed air, and at which point the expansion takes place, is important and requires its area to be exactly gauged to the proper size for the delivery of the desired volume of air at the assigned pressure. At 30 pounds pressure, air flows through an orifice in a thin plate at the rate of 525 feet per second. Then for the plant as above described, for the issuance of 5 cubic feet of free air per minute under a compression of 3 volumes in 1, is $\frac{5}{3 \times 60} = 0{\cdot}2777$ cubic feet of compressed air per second, and $\frac{0{\cdot}02777}{525} = 0{\cdot}0000529$ of a square foot area. Then $0{\cdot}0000529 \times 144 = 0{\cdot}0076176$ of a square inch. Then enlarging for the coefficient of efflux, the orifice should be $\frac{1}{16}$ inch diameter, with a valve back of it to shut off the air flow when required. Means should also be provided for blowing off any water that may condense in the air pipes or storage tanks by the cooling of the air after compression.

With proper care and a moderate outlay the system of cold storage by compressed air becomes a simple, efficient and economical adjunct to the living comforts of every home in a warm climate not blessed with a nearby ice-making plant.


Compression Volume
Temperature of Compression.
Temperature of Expansion. Fah.
Pressure per sq. inch.
Adiabatic, or Heat Curve of Compression.
Isothermal, or Curve of Shrinkage to Normal Temperature.
Atmospheric Line
Cold curves of expansion from normal temperature and pressures on isothermal line.
Graphic Diagram.
Compression & Expansion of Dry Air
G. D. Hiscox, M.E.
361 Broadway N.Y.

IN sorting over the letters from various parts of the world, 197 different ways of spelling "Chicago" have been found; among them "Jagjago," "Hipaho," "Jajigo," "Schecchacho," "Hizago," "Chachicho," and a scholarly resident of Finland indulges in "Zizazo."

TEXTILE SOAPS.

SOAP is very extensively employed in many branches of the textile industry. There is scarcely a single fabric of any material manufactured which does not pass at one stage or another through an operation in which soap plays a part. Seeing this, it is evident that the production of textile soaps must be an important industry; in fact, there are firms who manufacture soaps for this purpose alone. The objects for which soap is employed are as varied as the textile fabrics themselves.

The quality of the soap depends very largely on the kind of fat employed, which may be of animal or vegetable origin, and also upon the care taken in the process of making; good materials may be spoiled by faulty manipulation in soap boiling as in other work.

Wool Soaps.—Soap is employed in three stages, if not more, in the manufacture of the raw wool fiber into cloth. The very first operation that wool undergoes is that of scouring to free it from grease and dirt; this is done either by treating in a warm soap liquor, or in a warm bath of carbonate of soda, or potash. Some wool scourers use a mixture of both. Many wool scourers use a very common kind of soap for this purpose, made with soda from poor qualities of fats, and consequently dark colored, as well as often being imperfectly saponified. Bone tallow, tripe tallow, low grade palm oil, and oleic acid are much used in making such soaps. They are best left slightly alkaline, the excess of alkali being neutralized by the grease of the wool. Too great an excess of alkali, however, should be avoided, as it tends to make the wool harsh to the touch, and if soda has been used, yellow in color. Potash gives the best soap for wool, inasmuch as the alkali has greater scouring properties, while it has little action on the wool fiber, the latter being left softer and more lustrous in appearance. A good sample of a soap for scouring wool will contain 62 per cent. of fat acids, 8 per cent. of combined alkali, ½ per cent. of free alkali, ¼ per cent. of free fat, 29¼ per cent. of water. A soft soap will contain 50 per cent. of water, ½ per cent. of free alkali, ½ per cent. of free fat, 6 per cent. combined alkali, 43 per cent. of fat.

The soap should be fairly soluble, so that a good strong soap liquor can be made without being thick. Tallow and palm oil make a hard soap not readily soluble in water.

After the wool has been scoured to free it from grease and dirt, it is necessary to oil the wool before it can be spun and woven. Before the yarn or cloth thus made can be dyed and finished, it is needful that this oil be extracted, and for this purpose nothing has been found better than soap. Generally the same kind of soap is used as for the scouring; a very favorite soap, because it is cheap, is one made from bone tallow and cotton oil; this soap lathers pretty freely, and it is usually considered that a soap which makes a good lather clears the wool from the oil fairly well. Another good soap is made from palm and cotton oil. In the case of soaps for removing oil from wool, it is of very great importance to use one of good quality, or it may not remove all the oil, thus causing uneven shades in the subsequent dyeing operations. It is also important that soap itself should contain nothing which would be liable to fix upon the wool and interfere with the dyeing. The fats employed ought to be quite pure, and free from any unsaponifiable matter. For this reason bone tallow is not good, as it contains some phosphate of lime, and carbonate of lime, as well as animal matter. The lime has a tendency to form lime soaps, which eventually get on to the wool, forming grease spots. Recovered greases should not be used, as they often contain perceptible quantities of unsaponifiable matters. A soap made from pure fat has none of these defects.

Woolen cloths after being woven and dyed have to be milled or fulled. This operation causes the fibers to felt together, and so make a more durable and less impervious cloth. This milling is also accomplished by working the goods in a soap liquor.

The soap here has very little actual work to do, its principal function being that of a lubricant facilitating the movement of the fibers one over the other and assisting the process of felting. But even if the soap has not much actual work to do, there are still some things it must not do. It must not cause the colors of any dyed material to bleed, nor must it change the tone or dull the hue of any dyed goods. This can only be avoided by the employment of a soap as free from alkali as possible. A perfectly neutral soap is best. Such a soap requires care in making. The soap, too, ought to have good lathering properties and be pretty freely soluble in water. It is therefore best made from olive, cotton, or other similar oils. Tallow and palm oil do not yield lathering soaps. A potash soft soap is the best, but it is rather more difficult to make of the desired degree of neutrality.

Cop soap is used in the spinning of cotton. It has been found that by smearing the bottom of the cop spindles with a little soap the bottom of the cop is formed better, due to the threads adhering together. For this purpose a soft soap is found to be the best. It ought to be free from color; hence these soaps should be made from tallow, olive, groundnut or cocoanut oils. They should also be free from mineral oil or paraffin wax, as such have a tendency to soak into the cotton fiber, and cannot readily be extracted, thus causing stains when being bleached or dyed.

Calico Printers' Soap.—The calico printer makes great use of soap. He employs it first to cleanse the calico from the gum or other thickening agents which he is obliged to add to his printing colors. Then it often has a brightening effect, as with alizarine colors.

Most calico printers prefer to employ a soap made from palm oil for this purpose, chiefly on account of the fact that palm oil makes a soap which has a pleasant and agreeable odor, and does not easily turn rancid. Tallow, cocoanut oil, and castor oil, while making soaps which are satisfactory in other respects, often turn rancid, especially in the case of the last two oils. The soap must be well made, and, above all, must not contain more than traces of free fat and free alkali, the latter acting upon the colors and changing their tints. A good printer's soap will have a composition approximating to the following: Water, 23·5 per cent.; alkali as soap, 9·0 per cent.; alkali free, 0·2 per cent.; fat free, 0·2 per cent.; fat as soap, 67·1 per cent.

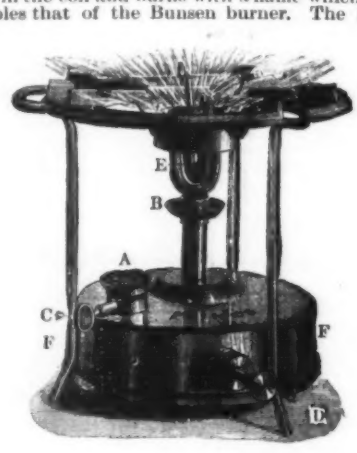
Olive oil soft soaps are also used by calico printers for much the same purpose; these are easily made by boiling olive oil and potash together.

Softenings.—In the finishing of cotton cloths what are known as softenings are much used. These are nothing more than highly watered soaps. The writer has found as much as 80 per cent. of water in such materials. This quantity is rather excessive, but from 50 to 60 per cent. is permissible. Softenings vary very much in composition: some are simply made by taking an ordinary tallow or bleached palm oil soap and boiling it in water until melted, then allowing to cool; others are made direct from tallow, palm oil, or cocoanut oil, and then thinned down with water to the required degree of consistency. Another form is made from cocoanut oil by means of a cold process. Sometimes paraffin wax is added. Softenings should be white in color; they therefore ought to be made from tallow, bleached palm oil, cocoanut oil, castor oil, or other white oils. They ought to be neutral in properties, so that they do not affect the color of any printed or dyed goods they may be brought in contact with.

Silk Soaps.—For degumming silk nothing has been found better than a good olive oil soap. A silk soap should possess the following properties: It ought to be neutral, inasmuch as alkali tends to make the silk somewhat harsh and reduce its luster, and it should be easily soluble. The soaps used in the boiling off of silk must be well made curd soaps, using as slight an excess of alkali as possible and well salted out. The soap must also be capable of being readily washed out of the silk. A soap well made with potash and olive oil would be found to give excellent results in the boiling off of silk.—Chem. Tr. Jour.

LAMP FOR BURNING OIL WITH A SMOKELESS FLAME.

THE apparatus has an airtight reservoir, F, capable of containing about two pints of ordinary paraffin burning oil, and which can be filled at tubulure, A. The burner is similar in construction to that of the well known "showman's naphtha lamp." Directly below the burner is a small cup, B, into which spirit of wine is poured. On igniting the spirit the coil of pipe, E, becomes red hot. By means of the small air pump, D, a few strokes of which is sufficient to compress the air in the upper portion of the reservoir, the oil is forced through the red hot coil and becomes vaporized. The oil vapor escapes through a small orifice in the coil and burns with a flame which closely resembles that of the Bunsen burner. The heat of



this flame maintains the gasifying temperature in the "retorting" apparatus. Thus, so long as the pressure is maintained and the oil supply lasts, no further addition of spirits of wine is necessary, and the lamp continues to burn with an intense, smokeless and odorless blue flame.

By turning the screw, C, and thus relieving the air pressure on the surface of the oil, the lamp is extinguished.

The amount of oil consumed during a period of from 20 to 30 hours costs about two cents.

EXPLOSIVES AND THEIR MODERN DEVELOPMENT.*

By Professor VIVIAN B. LEWES.

LECTURE I.

THE ordinary phenomena of combustion, which supply us with warmth and light, are all dependent upon the evolution of heat during chemical combination, and a study of combustion has shown us that by slowing down the rate at which the chemical actions are taking place, we can obtain those phases of combustion in which the heat is developed so slowly that it has ample time to dissipate itself into the air or to surrounding objects, and although the chemical actions are still proceeding our senses cease to observe the increase of temperature due them. From this it is reasonable to expect that if we could alter the rate of interaction in the reverse direction, we might arrive at a new set of phenomena due to the intensity of heat developed by the increased rapidity of combination.

It can readily be proved that when organic substances containing hydrogen undergo decay, some of the hydrogen present unites with the oxygen of the air to form water, and the heat generated by the combination is spread over so long a period that at no moment of time is it perceptible to the senses. If, however, hydrogen gas is confined under pressure in a gasholder, and allowed to escape through a jet into the air, on being ignited it burns with an intensely hot flame, the heat energy of which can be converted by suitable contrivances into other forms of energy, such as mechanical work. In this case as much hydrogen is converted into water in the course of a minute as would have been formed in some years by the process of slow combustion, and the increase in calorific intensity obtained is solely due to the increased rate of combination, the total thermal value of the hydrogen being the same, whether it is burned by a slow process or a rapid one.

If we now burn the jet of hydrogen from the oxhydrogen blowpipe and urge on combustion by feeding the flame with a stream of oxygen blown into its center, we still further hasten the combustion by saving the time necessary for the hydrogen to seek out the oxygen molecules from the diluting nitrogen of the air, and the result is an increase in temperature which gives us one of the hottest known flames.

If, instead of doing this, we supply a rapid stream of air to the outside of a hydrogen flame, we find that the combustion becomes irregular, and under certain conditions sound is emitted, as in the so-called singing flame, while if hydrogen be mixed with sufficient air to supply it with the oxygen to convert it into water, and if a light be applied to the mixture, the molecules of hydrogen being side by side with the oxygen necessary for their conversion into water, combustion takes place with enormous rapidity, and the intense heat generated expands the vapor formed to such an extent that an explosion results, while this result may be still further accentuated by increasing the rapidity of combustion by using pure oxygen in the right proportion to mix with the hydrogen. It is evident, therefore, that explosion may result from intensely rapid chemical combination.

As we investigate the actions which lead to explosion, we soon find that in many cases increasing the rapidity of chemical action does not bring about this phenomenon, if the products of the action only occupy the same or a smaller space than the original substance, unless they can for a moment be largely expanded by the heat developed by the action.

True explosion must, therefore, be looked upon as intensely rapid chemical action giving rise to gases or vapors which, being largely expanded at the moment of their formation by the heat developed during their action, occupy an enormously larger volume than the original substance.

The force of an explosion is due to the pressure which the gaseous products exert upon any confining envelope, and this is dependent upon the volume of gases evolved, and the amount of heat liberated and able to act in expanding them, while the destructive effect is, as a rule, largely dependent upon the time taken in their formation.

The smaller the space into which the original explosive can be packed, the greater will be the effect produced; a mixture of air and hydrogen explodes, but the explosion is much more violent if the same quantity of hydrogen is mixed with pure oxygen instead of air, as the retarding influence of the nitrogen is removed, and the mixture occupies less than one-half of the space occupied by the air and hydrogen.

The explosion of a mixture of hydrogen and oxygen produces a pressure of 240 lb. on the square inch, which is very small as compared with gunpowder, which gives on explosion a pressure of 40 tons on the square inch, this being due to the fact that the ingredients of the powder are solid, and therefore occupy the minimum amount of space; if the mixture of hydrogen and oxygen were compressed to the same density as gunpowder, it would develop on firing a pressure of over 300 tons on the square inch.

Oxygen is necessary for all the ordinary forms of combustion, but oxygen could not be used in the gaseous condition in explosives, as it would occupy too large a space; there are, however, certain compounds rich in oxygen, which hold it in such feeble combination and are so ready to give it up to bodies capable of being oxidized, that they can be used as a form of compressed oxygen, and by their decomposition they supply to the combustibles present in the explosive the oxygen necessary to convert them into large volumes of gases.

It is of great importance that the combustible and the supporter of combustion in an explosive mixture should be in as fine a state of division as possible and well mixed, so that at the moment of explosion each molecule of combustible shall find itself side by side with the molecules with which it is to combine, and that as little inactive material as possible should be present. The important effect of these conditions may be shown by taking four small pieces of phosphorus of equal size, and placing one on a saucer, when it will enter into slow combustion with the oxygen of the air, and if the day be warm, the temperature may rise to the point necessary for rapid combustion; but, if not, many hours will have elapsed before the action is complete, and the last of the phosphorus oxidized. The second piece can be ignited in a deflagrating spoon, and immersed in a bell jar of air, when it will burn away in a few minutes with evolution of heat and light; while if the third piece be now ignited in the same way, and plunged into a jar of pure oxygen, it will burn away still more rapidly, and the increase in calorific intensity is shown by the bright light produced

If now the fourth piece of phosphorus be dissolved in a few drops of bisulphide of carbon, and this solution be poured upon a small heap of powdered potassic chlorate, placed on a piece of blotting paper supported on the ring of a retort stand, the bisulphide will evaporate and will leave the phosphorus in a very finely divided condition on the surface of the chlorate, a violent explosion ensuing, this being brought about by the spontaneous ignition of some of the finely divided phosphorus which causes the chlorate to decompose, and intensely rapid combination of the remaining phosphorus with the liberated oxygen takes place. This is decomposition, which evolves heat, and the heat so generated, together with the heat produced by the combination of the phosphorus and oxygen, gives great calorific intensity on account of the rapidity of the action, causing enormous expansion, and consequent violence of explosion. The intense rapidity of combustion was in this case due to the fineness of division of the phosphorus, and to the small bulk into which the oxygen was compressed, the chlorate necessary to burn the phosphorus only occupying roughly $\frac{1}{10}$ of the volume of gaseous oxygen necessary, or $\frac{1}{50}$ the volume of air.

The explosives in use may be classified into mixtures and compounds, the former class containing the combustible, and the oxygen supplying substance in the condition of intimate mechanical mixture, while the latter class consists of organic compounds, containing

* Four lectures recently delivered before the Society of Arts, London.—From the Journal of the Society.

oxygen loosely held in combination by nitrogen, the oxygen on any disturbance of the molecular structure of the compound entering into new combinations with the carbon and hydrogen already present in the molecule. In some of the new explosives these two classes are combined, and the gas-generating power of the second class is augmented by the admixture of highly oxidizing substances, which tend to render the combustion more complete, and so increase the amount of heat generated.

Gunpowder, which is the most important and most commonly used of the explosives, is an example of the first class, being an intimate mixture of potassic nitrate or saltpeter (which supplies the oxygen), sulphur, and charcoal. English black service powder has the average composition :

Potassic nitrate	75
Charcoal	15
Sulphur	10
	100

Although in some of the new slow-burning prismatic powders the percentages of potassic nitrate and charcoal have been increased, and less sulphur used, the service powders of various foreign governments approximate closely to this composition :

Country.		Potassic nitrate.	Charcoal.	Sulphur.
England	Black powders	75	15	10
	Brown powders	79	18	3
Sweden		75	15	10
Russia		75	15	10
Prussia		74	16	10
Saxony		74	16	10
United States		76	14	10
Austria		75·5	14·5	10
France		75	12·5	12·5
Belgium		75	12·5	12·5
Germany		76	14	10

The value of a powder is to a great extent dependent upon the purity of its constituents and the processes by which it is mixed, as well as on the form in which it is finally made up, and in the manufacture of service powder all these points must receive the greatest attention. Discovered and used long before the Christian era, gunpowder has undergone but few changes in composition, and it is remarkable that these changes have been restricted to comparatively short periods; the first of which may be taken as comprising the fifteenth century, while the second and most important has occurred during the past thirty years.

Invented according to tradition by the Chinese, and rediscovered, probably independently, by Roger Bacon, in 1267, and by Berthold Schwartz, in 1320, we have ample proof of its being used for warlike purposes at the battle of Creey, in 1346, but it was not until the last years of the fourteenth century that any improvement was made in the proportions in which the ingredients were present. Up to that time, the carbon, sulphur, and saltpeter had been blended in practically equal proportions, but at the end of the fourteenth century a gradual increase in the quantity of saltpeter used began to be observable, and the writings of the Italian Tartaglia showed us that before 1537 the proportions of the ingredients had been improved until they closely approximated to the composition of the ordinary powders of to-day.

Simultaneously with improvements in the composition of the powder attempts were made to improve its mechanical condition, and undoubtedly the most important of these consisted in converting the finely powdered and mixed constituents, which were known by the name of meal powder, into grains which would be more convenient for handling and which at the same time, by opposing less resistance to the passage of the flame among the particles, increased to a great extent the rapidity of its combustion.

The earliest attempt in this direction was to sprinkle the meal powder with a spray of water which caused the fine meal to collect into small spherical masses. These were afterward gathered together and dried, but the ease with which such grains crumbled into fine powder again prevented any important increase in the rate of combustion being attained, and it was not until the idea was adopted of compressing the meal powder into dense hard cakes and then again breaking these up into grains of the required size that any great advance in this direction was made.

These improvements having been effected, the importance of mixing the ingredients in such a way that the maximum intimacy of the mixture should be attained began to attract attention, and the perfection in this direction which has been reached by the manufacture of English powder shows in marked contrast to the powders used in some Eastern countries. The most important era in the history of powder is undoubtedly to be found in the improvements and alterations made during the last three decades, during which period the combined scientific knowledge and engineering skill of those whose names will be always remembered in connection with this work have removed gunpowder from the ranks of ordinary explosives, and have made it an absolutely reliable propellant.

The causes which led to these alterations were to be found in the new forms of guns which commenced soon after the close of the Crimean war, and with the changes from the short smooth bore cannon to the long rifled ordnance of to-day, a corresponding alteration being necessary in the rapidity with which the powder developed its propulsive force, as the sudden impulse which the grain powders employed at that time gave to the projectile in the guns then in use would have developed strain of a dangerous character in the breech of some of the modern forms of artillery, and at the same time would have given an extremely low muzzle velocity to the projectile.

With the introduction of rifled ordnance, a change came over the science of gunnery, and an enormous increase in the size of the guns and in the charge of powder used followed. During the Crimean war, the largest guns used were the 68 pounder smooth bore guns, weighing 112 cwt. and using a charge of 18 lb. of powder, while at the bombardment of Alexandria, the smallest gun used was a 6½ ton one, using a charge of 30 lb. of powder, and at the present time 110 ton guns are being employed with a charge of 960 lb. of powder, and it is evident that the form of the powder must be modified to keep pace with such radical alteration in the conditions under which it is to be used.

It is required of a perfect powder that when the charge is fired in the breech of the gun, the combustion shall commence comparatively slowly so as to gradually overcome the vis inertiæ of the projectile without throwing too great a strain on the gun, and that, as the projectile passes up the bore of the gun, the combustion shall increase in rapidity so as to supply gas more and more rapidly to increase the momentum of the shot, which should leave the muzzle of the gun with the maximum velocity. In the old-fashioned grain powders this was never secured, and such powders could not have been used in the modern long bore guns, as the rapidity with which they burnt threw an enormous strain upon the breech, and would have given the maximum velocity to the projectile before it was half way up the bore of the gun, leaving friction to reduce the velocity to a considerable extent before the muzzle was reached.

The rate at which the combustion of gunpowder takes place, and at which therefore the pressure is developed, can be modified in various ways, by mechanical means. As has already been seen, the rate can be diminished by burning the powder in the form of meal, but such a method would be inadmissible in practice, as the density of the mixture is very low, the charge would occupy too large a space.

The combustion might also be retarded by reducing the intimacy with which the ingredients are mixed, but this again would be a bad and unscientific method to adopt.

The elimination of these two methods practically reduces the mechanical means for modifying the rapidity of the burning of the powder to three :

1. Varying the size and forms of the grains of powder.
2. Varying the density of the powder.
3. Varying the surface coating of each individual grain or mass, so as to retard or accelerate the ignition.

The English committee of 1857 was strongly of opinion that it was not right to modify the proportions in which the ingredients existed in gunpowder until they had exhausted all other devices for reducing the rate of burning, as an alteration in the proportions would sacrifice a certain amount of the total explosive force developed by a given weight of powder, and as the result of their labors, the first methods employed were of a purely mechanical nature.

The first step was to increase the size of the grains used for cannon powder at that time, and the larger grain powder gave fairly good results with the first modified forms of guns then introduced, but as the guns and charges increased in size, this powder in burning became too violent, and the next step was to produce a powder in which the grains should be uniform in shape and size.

This was done by compressing the meal powder into small moulds, so as to obtain small cylindrical pellets of about ¾ of an inch in diameter and ¾ of an inch in height, with indentations at each end in order to increase the surface.

The manufacture of this powder was, however, somewhat costly, and in order to facilitate the manufacture, a powder less regular in size than the pellet powder was produced by compressing the meal powder into cakes, and then cutting these cakes again into small cubes of about five-eighths of an inch, and from these small cubes the charges of powder in the guns were built up, and later on experiments were made by increasing the size of these cubes until a large pebble powder, consisting of cubes of 1½ inches, was arrived at.

With all these forms of powder, however, maximum rapidity of burning and evolution of gas take place at first, owing to the ignition spreading over the whole surface of the cubes, and instead of the gas coming off with more and more rapidity as the space in the gun became larger, the evolution rapidly diminished with the decrease of surface caused by the burning away of the powder.

In order to avoid this defect as far as possible, built up charges were resorted to, and it was Gen. Rodman, of the American service, who first tried to overcome this difficulty by building up the charge of solid slabs perforated with holes, so as to expose the minimum surface of powder at the commencement of combustion, while the enlarging holes produced a greater and greater surface of powder as the space behind the projectile increased. This idea has quite lately been revived, but large perforated cakes are always liable to break, and it was found far better to build up the charge of hexagonal prisms with a central core moulded in them.

It was in accordance with this idea that the black prism powder was first made, and the increase in rapidity in combustion is due first to the enlargement of the core and subsequent exposure of a larger surface, and to the fact that as the walls of the prism grow thin they break up, converting the powder during the last moments of its existence into what is practically an R. L. G. powder, thus giving enormously rapid combustion due to the exposure of a large number of fresh faces.

That this is really the case is shown by a prism being occasionally blown out with the projectile and extinguished by the sudden rush through the air, when it is seen to have been partly consumed and broken up in this way.

Side by side with these advances in the mechanical tempering of the combustion, other advances equally great in the manufacture were being made. It was realized that in order to obtain uniformity of results, absolute uniformity of ingredients, mixing, incorporation, pressure, density and degree of dryness, as well as uniformity in size, must be attained, and new methods were introduced into the process of manufacture with this object in view, great attention being also paid to the "finishing" of the powder prisms and the blending together of various batches of powder which presented any variation in their ballistic properties.

With the continued growth, however, in the size of the guns employed, other changes became necessary, as even when using the black prism powder for built up charges the pressure given began to throw too severe a strain upon the breech of the gun, even when the cartridges were made up in such a way as to leave air spaces at the seat of the charge in order to relieve as far as possible the initial pressure.

In order to secure further modifications in the pressure developed, it soon became manifest that chemical alterations in the composition of the powder would be necessary. Sir Frederick Abel and Sir Andrew Nobel had already made researches which conclusively showed that advantages might be secured in powder to be used in heavy guns by increasing the proportion of carbon and reducing the quantity of sulphur present, when Mr. Heidmann and Mr. Duttenhofer almost simultaneously produced a prismatic powder, in which the saltpeter was increased in quantity, the sulphur reduced and low-burned charcoal in larger proportion was employed. This powder, which received the name of "Cocoa powder," from the brown color imparted to it by the semi-charred woody fiber, gave a considerably lower initial strain and a much longer sustained action when used in large guns.

In these powders not only did the change in the proportions of the ingredients effect a considerable alteration in their point of ignition and rate of combustion, but the introduction of charcoal produced at a comparatively low temperature also brought into play other important considerations.

The charcoal used in making powder was at one time looked upon as being practically pure carbon, but it also contains certain proportions of hydrogen and oxygen remaining from the woody fiber from which it is formed, and it, moreover, has the property of absorbing oxygen and moisture with considerable rapidity from the air, and the parts which these substances play in the explosion of the powder are only now beginning to be thoroughly understood.

The amount of hydrogen present in charcoal exerts an important influence upon the ease with which it can be ignited, but the presence of hydrogen and oxygen also reduces its thermal value, so that, although the value of pure carbon is equivalent to 8,080 thermal units, the thermal value of the charcoal used for powder making rarely exceeds 6,600.

Where it is important to retain a certain proportion of moisture in powder, low-burned charcoal is of the greatest value, and the straw carbonized by superheated steam, which was used in the cocoa powder, played a most important part in imparting to the densely pressed prisms sufficient hygroscopic power to enable it to hold the necessary percentage of moisture.

The introduction of the cocoa powder was a great advance, but with the heaviest guns it became necessary to obtain even slower combustion, and by slight modifications in composition, the present service powders known as S. B. C. and E. X. E. prism were introduced.

The E. X. E. is used in the 6 inch breech-loading and R. M. L. guns, while the S. B. C. is employed in the 68 and 110 ton guns.

The E. X. E. prism is distinguished by its slate color and by a groove moulded round the core, while the S. B. C. prism is recognizable by its brown color and by a circular indentation round the core.

In making the new prism powders the ingredients are first accurately weighed out, allowance being made for the moisture present in the refined saltpeter, and are then mixed in charges of from 50 to 60 pounds in a revolving gun metal drum, which contains arms revolving in an opposite direction to the drum itself. The mixture is then passed through a coarse copper sieve to make sure that no solid foreign material is present, and is then called "green charge." This is now taken to the incorporating mill, which consists of two iron or stone edge runners weighing from three to four tons, which revolve on a bed made of the same material as the runners themselves and having a sloping rim. The runners are worked by machinery from below and make seven to eight revolutions per minute.

The green charge is placed on the bed of the mill, and is moistened with a very small quantity of distilled water, to prevent any of the charge escaping as dust, and also to aid the incorporation.

The green charge is milled for from three to eight hours, according to the nature of the powder, and a workman constantly pushes the charge from the outside to the middle of the bed plate with a wooden "shover," so as to keep it under the runners.

The incorporating mills are in a long building containing six mills, each of which is shut off from the next by a partition, while over each mill is an iron cistern connected by a lever arm to a large wooden shutter which is exactly over the bed of the mill; explosion of the charge would raise the shutter and deluge the mill by upsetting the tank. All the tanks work on one shaft, so that the upsetting of one would drown the charges in all the mills.

The mixture, which is now called mill cake, is next conveyed to the breaking-down machine, where the mill cake is placed in a hopper and is carried by an endless band to the top of the machine and then falls between a pair of grooved rollers and afterward between plain rollers, which break it into what is termed "meal." This meal is now packed in layers in the press box, and is subjected to a pressure of 70 tons on the square foot for about fifteen minutes, which renders it exceedingly hard and compact, and in this condition it is called "press cake." This is granulated by making it pass through successive pairs of grooved gun-metal rollers, which reduce it to the required size.

The prisms are now made by taking the granulated press cake and compressing it in a hydraulic press machine into regular six-sided prisms. These prisms are made under enormous hydraulic pressure in phosphor-bronze moulds, and are perforated by a hole through the center, so that when built up in the cartridge the flame can have free access from end to end of the whole charge.

Great attention is paid to the stoving of the new forms of prism powder—E. X. E. and S. B. C.—as the amount of moisture in them has an important bearing upon their rate of explosion, and they are dried first for 24 hours at 32° C. and then for 12 hours at 60° C., which leaves them with from 1·7 to 2·2 per cent. of moisture, which is the normal amount which these powders retain under ordinary atmospheric conditions.

(To be continued.)

THE APPLICATIONS OF OZONE IN THERAPEUTICS.

IN 1891 there was inaugurated at Saint Raphael a medical establishment in which anæmia, chloroanæmia and tuberculosis in a nascent state are treated according to the method recommended by Doctors Labbé, Oudin and Desnos, and which is based upon the oxidizing and antiseptic properties of ozone.

The medical establishment of Saint Raphael, the first of its kind that has been created, offers the peculiarity that chemically pure ozone is made there. The establishment consists of a vast structure of a pleasing style of architecture (Fig. 1) flanked by two well lighted halls. The salons of the casino occupy the first story, and the ground floor is set apart for hydrotherapathy and ozonotherapathy. Two large halls are particularly appropriated to the latter—the inhalation hall (Fig. 2) and the absorption one (Fig. 3).

After many experiments, the following is the general arrangement that has been adopted. The ozone is prepared by submitting pure and dry oxygen to the convective electric discharge. At the moment of inhaling it, it is mixed with a definite quantity of pure air. The nitrogen contained in this air has not the time to oxidize, and chemically pure ozonized air is obtained without a trace of nitrated compounds.

The apparatus comprise (1) electric generators, (2) a gasometer, (3) a distributing board for the oxygen and electricity, (4) transformers, (5) ozonizers, (6) an aspirator, and (7) inhalation vents. The electricity is produced by a Rechniewski dynamo actuated by a 10 horse power gas motor. The current furnished by this dynamo serves for charging a battery of accumulators which is utilized for the lighting of the establishment and for the production of the ozone. Five accumulators suffice for actuating all the ozonizers at the same time.

The gasometer consists of a cylindrical reservoir of thirty cubic feet capacity. It was at first filled by means of cylinders containing compressed oxygen, but since such gas is contaminated with many impurities, it is now preferred to prepare the oxygen directly by means of chlorate of potassium and binoxide of manganese. The gasometer is completed by a special apparatus in which the oxygen is dried and purified.

The apparatus situated in the absorption and inhalation halls are divided into three independent series that the distributing board permits of putting separately in operation.

There are two styles of ozonizers, one of which gives a large and the other a small discharge. The operation of these two apparatus is based upon the same principle—the polymerization of the oxygen under the influence of a convective discharge of electricity.

The ozonizer that gives a large discharge, and the use of which is more particularly reserved for the inhalation hall, consists essentially of a series of sheets of tin held respectively between two plates of glass. One sheet of tin and two plates of glass constitute one ozonizing element.

The elements contain two apertures at one of their extremities to allow of the passage of the gaseous current. At the opposite extremity the sheet of tin that is inclosed between the plates of glass is provided with a small appendage. A thin sheet of paraffined asbestos surrounds the elements and separates them from each other. All the even appendages are connected on the same side, while the odd ones are connected on the opposite side. The elements are arranged in a box covered with a special coating that protects it against the destructive action of the ozone. Two terminals lead the current to the even and odd sheets of tin. The current of oxygen enters through an orifice arranged at one side of the box, traverses in a zigzag manner the space comprised between the various elements where it is submitted to the convective discharge, and makes its exit thoroughly ozonized through an orifice in the opposite side

These ozonizers, which are strongly constructed, present, under a limited volume, a surface of discharge twenty times greater than that of ordinary ozonizers. In the ordinary model, which is of ten elements, the glass plates are 8×4 inches, and the sheets of tin $6 \times 2{\cdot}5$. The active surface of discharge is 190 square inches.

The model that gives a small discharge and which is more especially adapted to the absorption hall, consists of two concentric thin glass tubes. The internal tube, which is closed at one extremity, is stuffed with tinned paper, and at the other extremity is fixed a terminal that leads the current. The external tube is covered with tinfoil. A ring provided with a terminal leads the current. The oxygen enters through a lateral tubulure, traverses the annular space between the two tubes, where it is submitted to the convective discharge and makes its exit through the opposite extremity.

A powerful suction apparatus set in motion by an electric motor draws in air from the upper regions of the atmosphere, and this, freed from germs and dust by careful filtration through wadding, is mixed in the inhalation mouths or vents with pure ozonized oxygen. The inhalation mouths are thirty-four in number—ten in the inhalation hall and twenty-four in the absorption one. Each of them consists of two concentric tubes. The smaller one, which terminates in a tapering point, leads the ozonized oxygen. The larger one leads the air and terminates in a nickel-plated copper mouth piece. All the mouth pieces of the absorption hall are movable and each patient has his own. In this hall three mouths or vents are supplied by one and the same ozonizer. A cock mounted upon the tube through which the ozone enters, and the handle of which moves in front of a graduated sector, permits of regulating the entrance of the gas. In the inhalation hall two mouths are supplied by a single apparatus. Ordinarily only two large sized ozonizers are set in operation. At the end of a few minutes the atmosphere of the hall is strongly ozonized. The odor of the very pure ozone is mild and produces no irritation.

The arrangement of the inhalation mouths is very pleasing. In the inhalation hall (Fig. 2) the patients are not compelled to maintain a fatiguing immobility. Some come and go in talking, while others sit and read a paper. All of them, almost without thinking of it, inhale the beneficent and restorative ozone to the full extent of their lungs.

In the absorption hall (Fig. 3), the patients, leaning upon a large table, absorb somewhat stronger doses of gas that may be easily graduated at will.

In both halls fresh flowers are distributed in profusion. The brilliancy of their perfumed corollas has a pleasurable effect upon all present.

The results obtained in the treatment of the various affections naturally vary according to the age of the patient and the nature of the malady. The younger the patient, the greater the chance is of his being restored. The treatment by ozone is not applicable to lesions produced by diseases, but to the diathesis that has produced such lesions. It is by modifying the constitutional state of the patient that a certain and durable result is reached.

For anæmia and chloroanæmia, ozone may be considered as a certain specific. We regret that a want of space prevents us from citing some of the observations made by Doctors Lagrange and Bontem, of the medical establishment. All of them are most convincing.

With the establishment there is connected a laboratory of chemical and bacteriological analysis, where-

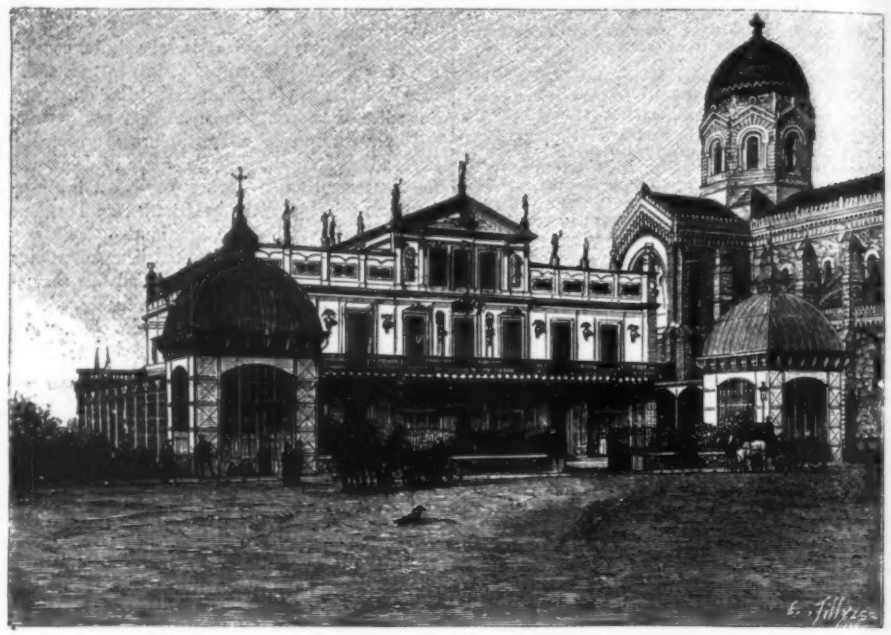


FIG. 1.—MEDICAL ESTABLISHMENT OF SAINT RAPHAEL.

FIG. 2.—GENERAL VIEW OF THE HALL FOR THE INHALATION OF OZONE.

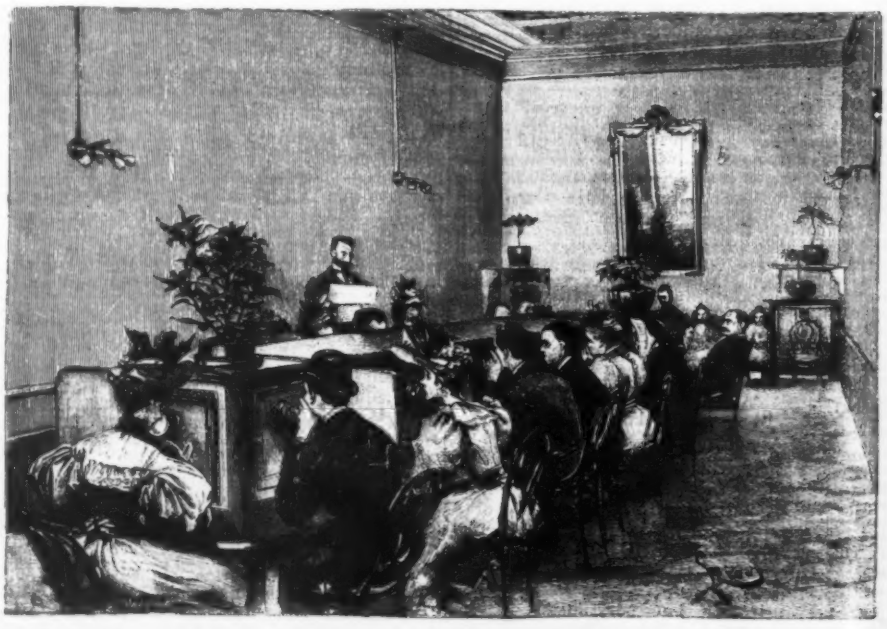


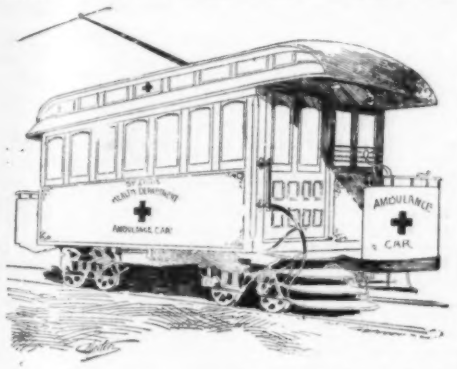
FIG. 3.—GENERAL VIEW OF THE HALL FOR THE ABSORPTION OF OZONE.

in new volumetric apparatus are employed for the analysis of the ozone. Here there is under study at present a portable inhaling apparatus that will be able to render great services to those who are prevented by their occupations from traveling to Saint Raphael to undergo the ozonotherapic treatment on the spot.—La Nature.

THE ELECTRIC AMBULANCE CAR.

As St. Louis was first to introduce to the world street car mail service, so she is first to put into use the idea of carrying sick and disabled persons to the hospitals on an electric car. The temporary service that has been in use during the past few months is to be supplanted in a day or two by an elegant ambulance car, constructed expressly for such service.

The new ambulance made by the St. Louis Car Company for John Scullin, president of the Union Depot car line, was run out onto the switch at Twelfth and Pine Streets, at seven o'clock the evening of December 27, 1894, and an hour or so later some score of invited guests made a trial trip in it. The car is higher than the ordinary car, is painted white outside, and bears the inscription on each side: "Health Department Ambulance Car," underneath which is a red cross.

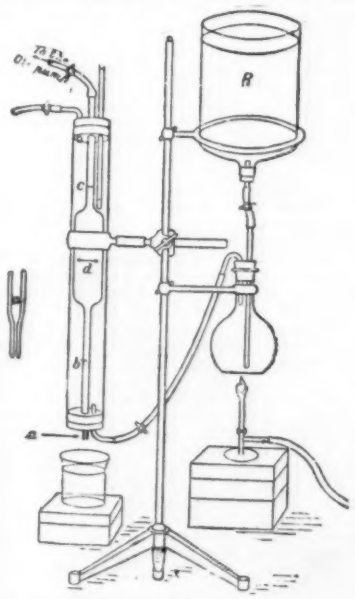


Access is obtained by wide steps, easy of ascent, with a neat hand rail at the side at each end of the car. Inside the car is finished in cherry, with quartered oak floor, and is equipped with eighteen folding chairs, twelve with arms and six without, and provided with rubber fenders to prevent slipping. Six litters or stretchers are carried, and are stored away in a closet when not in use. They are made of woven wire and rubber duck, with sliding handles and folding supporters. Blankets, air pillows, splints, bandages, instruments, drugs, dressings and all necessary appliances are carried, neatly stowed away in cupboards, drawers and closets. There are retiring rooms and lavatories, a desk for the doctor and shelves to hold instruments, etc., which fold to the sides of the car when not in use. There are electric bells for the surgeon in charge; not a detail, in short, of any possible use in an ambulance car has been omitted.

The interior is divided in the middle by a partition, one compartment being reserved for female patients. The partition folds to the sides of the car, so that both compartments can be thrown into one when not in use. The car is lighted by ten incandescent burners and heated by electric heaters. It runs as easily as a Pullman sleeper. We present a picture of the only electric ambulance car in the world.—Medical Fortnightly.

A SIMPLE VISCOSIMETER.

THE apparatus which is shown in the cut herewith consists of a pipette of fifty c. c. capacity, the lower end of which is drawn out to a cylindrical point, as shown in a; the stem has two marks upon it at

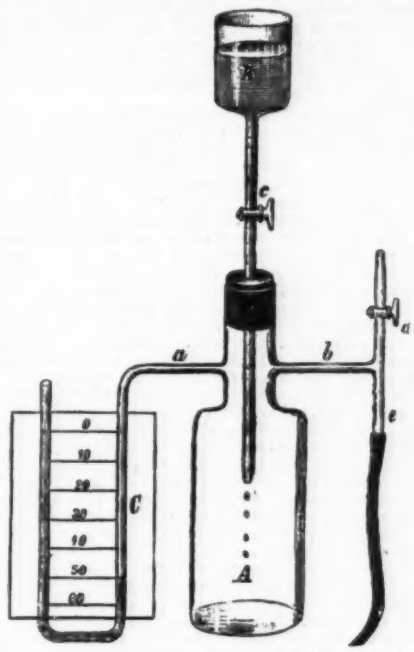


b and c. The pipette is held in position within a cylindrical tube by means of caoutchouc stoppers, and this tube is supported vertically by a clamp. Water is passed through the cylindrical tube from a reservoir, R; it may be raised to any desired temperature by the Bunsen's lamp. A thermometer placed through the upper caoutchouc stopper serves to register the temperature of the water passing through the cylindrical tube.

The liquid of which it is required to determine the viscosity is sucked into the pipette somewhat above the mark, c, and after being adjusted to this mark at a known temperature, the time is noted that elapses while the liquid drops out until it reaches the lower mark, b. The oily liquid collected in a beaker may be weighed and its specfic gravity deduced from this; the estimation of acidity may also be made in the same quantity.—M. Wendriner.

APPARATUS FOR OBTAINING A CONSTANT WATER PRESSURE.

THE method of using this apparatus is apparent from the figure: the tube containing the oil is attached to the apparatus by the India rubber tube, e. It is advisable to surround the flask with felt to prevent the influence of draughts, etc. By means of this appara-



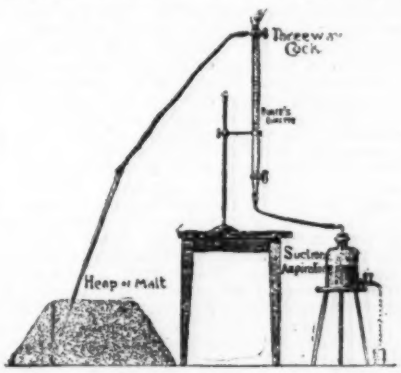
tus any required pressure may be readily maintained. —F. Gantter, Zeits. Anal. Chem.

RESPIRATION OF MALT ON THE MALTING FLOOR.

THE author has carried out a series of experiments on the practical scale in order to determine the variation of moisture and of temperature in germinating barley, and how high the percentage of carbonic acid rises in the air of the heap during the ordinary process of malting.

Steeping.—Barley containing 15·15 per cent. of moisture was steeped in water (changed as usual) at 46° Fah. for 70 hours, samples of 1,000 corns being from time to time removed and weighed. The increase of weight (disregarding the very slight loss by aqueous extract) gave the moisture absorbed by the barley. After 24 hours' steeping, the increase in weight (i. e., increase in moisture) was 32·35 per cent., after 48 hours 41·49 per cent., and at the end of 70 hours 48·52 per cent. The barley was then transferred to the malting floor.

Malting.—The malting was carried on for nine days, the temperature of the air of the malting chamber being 43–46° Fah. For the first five days the heap ("piece") was turned twice a day, then once a day. The tests for temperature and moisture were always made at five different places in the "piece." There was a further absorption of moisture during the first two days to a maximum of 55·57 per cent., after which there was a gradual loss of moisture, so that on the third day the excess of moisture over that originally present in the barley was 51·75 per cent.; on the fourth day 41·47 per cent., on the fifth 34·51 per cent., on the



sixth 33·69 per cent., on the seventh 31·20 per cent., on the eighth 33·04 per cent., and when the malt was removed from the malting floor 28·38 per cent. The moisture in the green malt was thus 33·95 per cent. of its total weight.

The temperature in the middle of the piece gradually rose from 51° Fah. on the first day to 79° Fah. on the fourth day, and then slowly fell to 62° Fah. on the ninth day. The temperature near the floor was generally two or three degrees lower than in the middle of the piece, and during the most active germination (i. e., from the third to the sixth day) the difference was 9° or 10° Fah., and in one instance 13° Fah.

The percentage of carbonic anhydride in the air of the piece was determined by inserting a pointed tube punctured with several small holes near the point, well into the piece. The other end was attached to a Bunte or Orsat gas burette, and this to an aspirator. After about a liter of air had been drawn into the aspirator, it was considered that that in the burette was a fair sample of the air of the piece. The accompanying sketch will render the method employed clear.

The average percentage of carbonic acid found was 5·40 on the first day, rapidly increasing to 19·4 on the morning of the third day, and then falling to 3·8 at the end of the fourth day, and 0·9 on the sixth day. Estimations of oxygen were made in many of the samples, to determine whether the increase of carbonic anhydride was accompanied by a corresponding decrease in oxygen. At first this was the case, but as the percentage of carbonic anhydride increased, the sum of the carbonic anhydride and oxygen exceeded 20·9 more and more, until on the third day, when the germination was most active, the carbonic acid was 19·1 per cent. and the oxygen 4·4 per cent., or an excess of 2·6 per cent. over the normal 20·9 per cent. This excessive formation of carbonic anhydride was also observed by Schutt, and is probably due to chemical processes going on even in the absence of oxygen, by which carbonic anhydride is liberated—a kind of self-fermentation.—H. Jaeschin, Wochenschr. f. Brauerei.

[Continued from SUPPLEMENT, No. 998, page 15957.]

SIBLEY COLLEGE LECTURES.—1894–95.

BY THE CORNELL UNIVERSITY NON-RESIDENT LECTURERS IN MECHANICAL ENGINEERING.

FUNDAMENTAL PRINCIPLES OF BUSINESS: THEIR APPLICATION IN PRACTICE.

By T. DUNKIN PARET, of Stroudsburg, Pa.

FROM these paradoxes of trade the beginner in business must emerge as best he can, must select some article and start resolutely on. Now let him strike out the non-essentials and keep clearly before him a few broad, general classifications. His stock and his staff, his capital and his interest, his expense and his profit. An entirely new stock might be perfect in theory, but not adapted to that particular neighborhood, while a new staff would be equally ignorant of stock and customer. Might it not be wiser, then, to buy out an established business? The stock would embody the old storekeeper's long experience, and ought to be cheap at cost. The books would vouch for the extent and character of the business, and a new inventory would verify the amount of the stock. Some of the old staff could be kept to retain the old custom and the outgoing dealer to be bound over not to take up the same business. Unfortunately, very few business men understand the real meaning of their own books, so the new purchaser can hardly be expected to appreciate their true story. If, however, the books seem correct and clear—if cost of purchase is evident, amount of sales unquestionable, and daily expense susceptible of demonstration, two factors remain of both questionable and unquestionable importance. The first is the book account. That is to say, the sundry debtors' ledger or the details of bills due to the firm and still unpaid. How much is good—how much is bad? "Oh!" says the beginner, "I won't let that trouble me! I won't consider the unpaid bills as an asset of the business, and the outgoing dealer can accept that risk and settle that doubt in his own way." This seems very well for the beginner, but in that very account lies one problem as to the future profit of the trade. Wipe out the old account, and a new one begins. From this time yearly till the end of the concern that account will figure in the assets, minus an annual deduction for proved bad debts, and in its doubtful and unproved remainder will lie a residue of serious import. Back of this lies in the dark another factor of greater power. It is the inventory account. Verified, of course, with all the zeal of a beginner and the accuracy of a youth fresh from his mathematics, and bought, cheap at first cost, the original buyer's experience thrown in for nothing. How long will it be before the new buyer learns that no old stock is cheap at cost? How much longer before he realizes that this asset, apparently simple and easily calculable, is the most profound mystery of his whole establishment—the skeleton which presides over his business feast—the vulture waiting for his firm's corpse, and Brahma-like, the carrion on which that vulture shall feed? How long will it be before his good-looking young clerk accepts a hundred dollar rise from some competitor, and carries the chewing gum trade of feminine adorers to the store on the other corner? How long before the retired proprietor opens a new store with larger plate glass windows on the sunny side of the street, and alleges, when sued for breach of contract, that the bargain was in restraint of trade and void?

From these terms of a village problem, with its factors of corner store and second-hand stock, let us change to a larger blackboard and more numerous set of figures. As we do so the problem grows more complex, and it is not always easy to strike out the non-essentials or see how a few principles pertaining to the smallest business underlie the most vast and far-reaching designs. Because of this complexity, we have have a world-wide fever of business, with all its attendant delirium.

Serious as is the interest question to the young storekeeper of the village corner, it is infinitely more so to the business world, as a whole. And yet the business world accepts as right, almost without question—accepts as the latest and most approved financial and business economy—a system which causes the bulk of its business to be done on borrowed capital. Money is one of the necessary instruments and tools of business, and in every trade but that of finance we clearly recognize that the tools must be proportioned to the work. If a mill of moderate size secures the government contract for envelopes, its first task is to multiply the machines in proportion to the contract. If a new territory is opened to settlement, or if the last census discloses a steady annual growth in the cultivated area of some old settled State, the farm implement manufacturer calculates the increased need of plows to turn up the sod, of drills to scatter the seed, of reapers to gather in the grain. But in finance all is different. With wonderful elaboration—with marvelous detail—with concise summings up, the United States census discloses the growth

of population—the increase of vested wealth—the expansion of production and interchange. All these these steadily increase in proportion and amount by steps which are visible and laws which are fixed. By the rule of common trades, dollars, which are the tools and instruments of all trades, ought to increase in definite proportion, in known quantity, by rules fixed and known. Instead of this, the production of money is left to chance—to the chance first of a fixed definite proportion between the silver and gold in the earth's recesses and in the channels of commerce, and, second, of a like fixed proportion in the demand for each—a chance which has resulted in the scarcity of one material and the overplus of another. Hence an uncertain annual supply of money, disproportioned to a certain and fixed annual increase of business. Then steps in the banker, and, for interest, lends that credit which he is glad to see pass current instead of money. The less the actual supply of money, the better the market for credit—the fewer the hand-to-hand payments, the more numerous are involved settlements by book credit, by time draft, by promissory note, by loan and discount—by every transaction which widens the circle of financial middlemen, and interposes the bank, the broker and the collection agency between the buyer and the seller.

Not content with its privilege of lending credit on interest as a substitute for the missing proportion of money, the banking interest, by sound argument and specious wile, tries to accumulate in its own coffers the largest possible proportion of real money. Hence a vast banking system, with immense deposit accounts subject to call; a huge array of trust companies, with the slow moving funds of trusts and estates; a prodigal supply of insurance companies, with their reserves locked up in city realty, a newer growth of bond and debenture companies spreading their accumulations among boomed cities and over farms scourged in succession by drought, freshet, grasshopper, cyclone and populist; and Wall Street, as a whole, scattering broadcast all its brands of sweetened, adhesive paper, knowing well how many innocent flies will be attracted and stick. In these vast aggregations of capital lies the possibility of those works whose increasing magitude is a wonder of the age. Hence rise the twenty storied office buildings—hence spring the arches which are to span a Hudson—hence starts the rail which shall cross a continent. And hence sink the foundations of individual responsibility. With pitiful abdication of self, with confiding innocence that is all too childlike and bland, the individual pours his pecuniary drop into the banking bucket, with a serene trust that the integrity and business sagacity of men he don't know is greater than that of himself. The banks tell him it is miserly to be a miser. That it don't pay to stuff greenbacks in a mattress or hide gold eagles in a bowl of dried beans on the kitchen dresser. So he puts his money in a trust company at one or two per cent. or in a national bank for nothing, and these philanthropic institutions loan it out for their own profit at six per cent. Unfortunately for the business world, those conservative business men whose capital is proportioned to their business are not large borrowers; so the banking interest backs up the weak and struggling at the expense of the sound and conservative, and, not finding enough of these to profitably employ its means, becomes the promoter of the most heterogeneous business enterprises.

As these enterprises increase in number and magnitude, the complexity of their business relations increases. Shift the scene from our corner store to the huge establishments of Carnegie, Edison, and Westinghouse, to the crossed and tangled wires of a Western Union, to the myriad-boned skeleton of an Atchison, and see how intricate are the problems of stock and staff, of capital and interest, of expense and profit. To a stock inventory of prodigious amount is now added a plant inventory of proportioned size, both so heterogeneous that even cost is an improper factor, while the soundest estimate is a wild guess. The business is a veritable one-horse shay, which runs just so long as the slenderest linchpin of a dividend sticks in, and drops all to pieces when the dividend drops out.

To these complexities, due to mere magnitude of amount and variety of assets, must be added the element of time. The enterprises launched by aggregated capital are so vast that long years elapse before the engines get in running order and the first trial trip is made. If the Hudson is to be bridged or a canal dug across the Isthmus of Panama, unknown years of steady outgo precede the doubtful beginnings of income and the still more doubtful beginnings of profit; hence, not merely a few large and uncertain enterprises, but a world-wide delirium of investment, which takes no note of the simple principles of the corner store, of the chewing gum man's subtile road to success, of the dead man's limitation to one coffin plate. British capital is piled in heaps wherever a British iron clad can give that indirect protection whose direct employment Great Britain so indignantly resents. Australia and the Argentine are fastened to Thread and Needle Street with golden bonds, and then Great Britain discovers that Australia and the Argentine have more quill toothpicks and matches than a limited population can consume. In mad confidence that mere weight of capital can make any enterprise a success, the possibilities of demand are flagrantly ignored. Water works, gas works, incandescent and arc light works, electric and cable tramways, belt railroads and parallel lines, irrigated deserts, mountain peak hotels, and cogwheel inclines—these are scattered with reckless hand for the benefit of a population which may possibly in time grow up to them—to the social destruction of every over-boomed locality and the pecuniary loss of an enthusiastically confiding and badly gulled public.

Let us now ask the question, "What is business?" The word comprehends almost every form of daily occupation, whether such occupation be gratuitous or have for its immediate object the acquisition of money. In ordinary acceptation it includes only those forms of occupation in which the party of the first part, "for value received," does something for or transfers something to another. One fundamental principle of business, often too late and too imperfectly appreciated, is that involved in the words "value received." When attached to a promissory note, the ordinary business man recognizes easily their legal and practical effect. When merely implied in the transfer of an article or the exercise in another's service of time or ability, the fundamental principle of "value received" is too obscure to be always self-evident, too vague to be easily identified. And yet, if there is any one thing which is clear, it is the law of implied warrantee. From this implication the manufacturer cannot escape. No disclaimer in catalogue or invoice will free him from the warrantee which is implied by his general offer. If he offer butter, it need not be "fancy dairy" nor even "creamery," but he can't enforce pay for lard or lubricating grease. If he offer an axe, the article supplied need not be of the costliest brand of steel, but it must not be edged with pewter, and must perform in some reasonable way the ordinary functions of an axe. It may be sold according to quantity, on a sliding scale of prices, but for equal quantities it is sold at the same price to the rich man as the poor.

Singularly enough there is a stratum of business which the world recognizes as a higher stratum—to which the young weakly aspire—on which the already attained rest with lordly pride in their own position and with ill concealed disdain for the ranks beneath, and in which the law of implied warrantee has little or no recognition.

This stratum is the professional one, and it plumes itself on its superiority to that trade element on which the British novelist has for generations poured contempt and scorn. Yet it is no libel to say that the professional man, as an ordinary thing, has little more concern for the result of his labor than that much-caricatured tradesman, the New York plumber, has for his. The latter carries out some elaborate system for the elimination of dirt and foul air, in which system leaky joints and uncalculated back pressures are made the means for distilling the sewer's miasm among the drawing room upholsteries and saturating the cellar soil with poisonous filth. And in his bill, as there was much time rendered and much material used, he takes an honest delight. He claims to be honest because he has supplied the material and time charged for, but he does not hold himself responsible for the attainment of a desired end. Just so the lawyer, the doctor, the professional expert—these, except in rare cases, assume no responsibility for the result. The lawyer settles an estate, and, whether his management beggars or enriches, charges in full for his time and his labor. The doctor enveigles some chronic sufferer into a course of treatment, and collects his fee through years of useless experiment, just the same as if he had made the lame to walk or the blind to see. The professional expert investigates the subject submitted to him, and collects for professional service, whether his report be a summary of sound conclusions or a tabulation false in figures and misleading in result. In these charges and settlements, the question as to value received has little lot or share. So many years of preliminary education, so much acquired reputation, so many visits or consultations at so much an hour—these seem the basis of the charge. They seem so, and yet are not. If they were, some reasonable basis might be arrived at, for reasonable limit might be set to the money value of education and repute. But doctor, lawyer, and professional expert, having first made out the bill from the standpoint of their own value, then amend it according to their estimate of the debtor's wealth. The millionaire's leg costs more to amputate than does that of the corner grocer, and the weak corporation pays a bigger lawyer's bill than the richer individual or firm. It will be answered that this is a slander on the professions, and that the big fees of the rich render possible that gratuitous or low-priced service to the poor which professional men are ever ready to extend. Granting this and admitting that the professions, like the trades, have their due proportion of unselfish, generous, philanthropic men; nevertheless, the fact remains that the fundamental principle of implied warrantee and value received has little place in the business or ethics of the professions. And, granted that the fees of the rich render possible gratuitous service to the poor, why should the professions exact from those whom they profess to serve money which the served might expend in charity as freely as themselves? When the surgeon's steel bleeds the millionaire cutler, it bleeds his purse and claims to give food and drink out of it to the poor. Were the millionaire cutler to reverse this process and charge to the surgeon, because rich and of high repute, an exorbitant price for the steel, no explanation would avail him that he proposed to give the excess to the poor.

And yet are not the trades competent to distribute their own alms?

Having thus asked the question, "What is business?" we now ask, "What is the object of business?" As previously hinted, the readiest and most general answer would be that the object of business was the acquisition of money. Money, being useless in and of itself, is a means, not an end; so we must also ask, "What is the object of pecuniary acquisition?" The first purpose of the money seeker is to maintain himself in reasonable comfort while engaged in the business of exchanging his time or his ability for money. The second is to transform reasonable comfort into luxury and provide for the gratification of tastes and desires. The third is to reduce the hours of money getting occupation and increase those devoted to tastes and pursuits not primarily leading to direct personal aggrandizement. The fourth is to amass and save from the proceeds of active business a sum whose revenue will furnish either reasonable or luxurious support, leaving the saver free from enforced labor and at liberty to follow occupations and pursuits without reference to moneyed consideration. In the four problems as just stated we have the one factor, "himself." Marriage adds a certain second factor and the potency of an indeterminate series. The individual implies the family, and, for "himself," we must read "himself and family." It would appear, therefore, that the object of business is to acquire money with the view of providing comfort, luxury and the gratification of desires and tastes for the family. The family, however, implies families, and the social relation steps in with a whole train of factors. Apparently the responsibility of the business man is not limited to his own family, and his duty is to seek the highest well being of himself and family just so far as he can do so without curtailing that of other families. Here let us a call a halt and reconsider this last conclusion. What a terrible and dangerous leap is this from the admitted doctrine that the boundary of each man's liberty is the liberty of his fellow? And yet a mania of sentimental sympathy is spreading through all lands whose end would be to rigidly limit the well being of individual and family to just such an average as would be necessitated by the equal division of the well being of the world among its total population. Were this done, the New York tenement house and the Dahomey hut would alike disappear, but the gates of Chatsworth would be closed forever and the suburban villa be seen no more. In raising the undeveloped savage or the retrograde of civilization to that average which is based on a universal level we would drag down and back the advance guard of human progress, the outmost pickets of the social camp, the watchers who have fixed their observatory above the fog of the valley and the murk of the labor-exhaling city.

A mania of sentimental sympathy we call it. Were it only a brute, ravening demand of the poor to share in the feasts of their betters, the emergency could be more easily met. But it is an insidious mania which becomes the obsession of the rich, the well to do, the comfortably off, the contented, the ungrasping, the philanthropic. A mania which sets them to calling in question their own moral right to their own inheritances and acquisitions, which makes them apologetic for being better off than their neighbors, which robs innocent indulgence of its joy and transforms the lovely attributes of pity and compassion into the death's heads of every feast.

While these gentle innocents sit trembling on their rightful lands—sit, like criminals in the dock, accused of social larceny and so appalled by the prosecutor's vehemence that they almost doubt their own innocence—the prosecutor pleads that these are useless beings, "who toil not, neither do they spin," a non-producing class, burdensome to that other class whose direct, hard-handed labor is the only source of wealth. But mark here the qualifying force of that one word "direct." In these days when the law of the transformation of force has become the daily tool of working mechanics, what legislator would dare to decree that every electric generator should expend hourly the sum of its production and that storage batteries should be no more? And yet the cow, the share in a building and loan society, the lot, the house, the saving bank pass book, the stock, the bond, the annuity, the policy of life insurance, these are the storage batteries in which the generators of wealth accumulate their daily surplus of unexpended product. Who dare say that these shall be no more? Who dare dictate the sum of each man's daily expenditure? Who dare gainsay the right of the individual to spend or to withhold—to squander or to save?

We need waste little time on the pitiful fallacy that direct, hard-handed labor is the only source of wealth. We scarcely need to point out that this so-called non-producing class furnishes its share of the demand which keeps in action the direct, hard-handed labor, and also supplies its share of that capital without which labor is but a shorn Samson. Let us fall back on that other charge that these non-producers are useless beings, a burden on the social back. Under this claim lurks the strangest heresy of a dying century—a heresy born in this new land and slowly permeating older ones. It is that heresy which attributes to man as his highest function the faculty of maximum production and imputes to him as a sin that other function—the faculty of maximum use. It is that heresy which crowns the producer and dethrones him whose needs and tastes are the final cause of the product. It is that heresy which brands as accursed and outcast from the social circle those middle and upper classes whose instincts toward a higher culture represent the inherited tendency of a race.

It is not strange that the newly enfranchised citizen should wax indignant and inquisitorial when his eager steps in the new path of social and political privilege are blocked by hereditary wealth and title whose origin is doubtful or shameful. But the latter-day heretic includes among the objects of his hate those successful ones of his own lower class whose earnings and savings have promoted them. Because they no longer produce by direct, hard-handed labor, therefore, they are useless. In this view the functions of a rising and upper class are ignored. In the evolution of these classes there is abstracted from the ranks of direct productive labor a certain number of strugglers, by which abstraction the evils of competition are mitigated. One function of these classes, probably the chief, is to develop that faculty of use on whose evolution the faculty of production depends, and we cannot too strongly urge that no superiority attaches to the producer as such, production and use being equal and correlative. In this retired class part only are so enriched as to be large consumers. Another part, equally dowered perhaps with education, refinement, breeding and taste, possess desire and critical sense, though their ability to acquire the possessions of others is limited. Of this circle of gentlewomen and unassertive men what useful function shall we predicate? These are to the body social what the health officer and the official inspector of weights and measures are to the trades. These are the detectors of adulteration, the adjustors of social standards. These stand between the social body and the cheats and meddlers who threaten it. These are to the current of popular thought and feeling what the filtering basin is to the turbid stream. They make it pause in its hasty flow and give it time to settle; they purify it before final acceptance. On this upper class the spirit of the time would levy its unequal tax, claiming that the rich man's dollar shall be more highly assessed than the poor man's. They forget that the impairment of the rich man's dollar is the weakening of the poor man's cent. Every infringement on the dollar's responsibility is a diminution of the dollar's value. The right to share equally in the dollar's burden is the poor man's title to his dollar's worth.

In this digression lies the refutation of socialism and communism—of the altruistic theory when pushed to its extreme. In it lies the vindication of that young business man of the future, who, instead of drifting into business, adopts it after careful study, with a clear conception of its end, making the family the social unit and striving his utmost for the well being of that family, even though his superior acquisition implies the inferior acquisition of another. In it lies also the implication that the family is only one unit of many and that the well being of one demands the well

being of the whole. In it lies concealed the fact that the smaller unit demands a larger. At first sight this larger unit appears to be the nation, but farther study shows that the national unit is often temporary, arbitrary, artificial, and that the real unit is the race; meaning by this, not the human race as a whole, but those diverse bodies whose origin is so uncertain, whose differences and identities are so profound. Too long accepted as a finality the national unit is being called in question and the racial unit being offered for adoption. All the tendencies of the time tend to the shattering of heterogeneous empires and the formation of strictly defined, one-race nations. The natural units are the individual, the family, the one-race nation.

But what bearing has this philosophic disquisition on "The Fundamental Principles of all Business and their Application in Practice"? Our answer is that in this conception of the social units may be found that final synthesis which detailed analysis and rigid striking out of the non-essentials leave behind them, from which synthesis as a basis every business man must start. Every man, in fact, for, from the standpoint of this lecture, every man is of necessity a business man. The highest development of himself, of his family, of his race—these are the first duties and the final ends of every business man. They are not necessarily incompatible with the equally high development of other men, families and races; but it is the business man's first duty to strive for his own, knowing that if each strives for himself and his own with success, no need will remain for altruistic effort.

"But how," you may ask, "is this fundamental principle of all business—self-seeking in its highest, holiest sense—to be applied in practice?" In the first place, every man about to adopt his life profession must inquire, not only as to its possibilities of acquisition, but as to its moral bearing and its final end. And here we must call attention to one striking feature of the age by which moral bearings and final ends are too much obscured. This feature is organization. Side by side with aggregations of capital have grown up aggregations of men. To the individual trader of primitive commerce has succeeded the firm. Dombey & Son are the lineal descendants of Dombey Père; Dombey, Son & Co. enlarge the late firm's assets and subdivide its official positions; then The Dombey Co., Limited, floats its stock certificates, and with them float away the remnants of individual responsibility. To cap the climax, The Dombey Co., Limited, surrenders its corporate independence and sinks its individuality in The Dombey Trust. The Dombey Trust mingles its reserves in the millions on deposit with some big investment company, and these are loaned—heaven only knows where!—probably to struggling competitors of The Dombey Trust, whom it is trying to crush out of existence, and who, in turn, are trying to cut its throat by reckless sales at unremunerative price.

Not satisfied with this destruction of his business personality, the end-of-the-century young business man goes on to still further self-effacement. He becomes one of a baseball team and member of an athletic club. He is a Patriotic Order of the Sons of America and an A. P. A. He is a Red Man, a Knight of Pythias, an Oddfellow and a Mason. He is going to take the thirty-third degree next week and be initiated the week after into an order so new it hasn't even got a name. He is a Blue Ribbon man, a Social Purity man and a Christian Endeavor young man. He belongs to the Building and Loan Society, to the Saint Cecilia Musical Band, to the Association of American Wheelmen. His muscular development, his race instinct, his benevolence, his provident forethought, his appetites, his religious tendencies, his desire to express by sound that which cannot be formulated in thought or speech; his latest weakness for the latest fad—all these have to be exercised under by-law and rule in common with the other members of an associated body. Like the heterogeneous string of societies which makes up the tail of a great procession on some festal day, and at whose sight the throngs desert the sidewalk, each faculty in turn is paraded through the public thoroughfare; its fringed apron and broad silk scarf declaring its distinctive character, and its banner proclaiming, like the heroes of Gilbert and Sullivan's operas—"I am the model of sobriety!" "I am the proper young man!" And all this time, at the head of the procession, challenging and receiving the admiraton of all, marches the real or the potential soldier whose one characteristic is that he is ready to face every duty on every field. It has been well said that all we know of progressive organization implies progressive localization of function; and the young man who joins a big society that he may exercise some one faculty becomes a subdivision of that subdivided function and exercises the decimal part of a faculty.

"But where are you leading us?" suddenly asks the affrighted young end-of-the-century man. "You are taking us away from the complex, the involved, the highly developed multiple relations of the time, and leading us back to the village corner and the country store." Why not? May it not be there that the final synthesis is found; there where the countless non-essentials of an involved modernity are struck out; where man comes in relations with his fellow man; where the producer and consumer exchange in person; where the farm wife's eggs pay at once, directly and without intervention or intermediary, for the farm wife's calico gown; where barter simplifies commerce; where Antæus touches the earth again?

While free traders and protectionists battle upon the platform, while financiers dispute about pecuniary currents and the outward and inward flow of gold and bonds; while professors of political economy corral their scattered lectures in the safe fold of a bound volume; the rustic of a remote and primitive community evolves from a traveling circus the true solution of the profoundest business problem; the doctrine of the balance of trade.

"That circus carried out of the county three thousand dollars!"

Enough to buy two lots, to put up two cottages, to lay the foundation for two homes.

When you adopt a profession, young man, what will you be? The sub-official of a manufacturing company, whose practically non-responsible stockholders are scattered far and wide; whose annual interest and dividend it is your duty to furnish; whose responsibilities to the public and to their own servants you can but handle most delicately or assume with personal risk? The occupant of a fourteenth story office whence you manage by typewriter and speaking tube and district messenger boy, and distant telephone, and earth-encircling cable the affairs of some mining company whose shafts are in the Way Off Mountains; whose product you have never seen, the real value of whose shares is a daily conundrum? The importer of goods made by under-paid labor in foreign lands, selling them here to the detriment of our own rising or established industries, and remitting to other races the proceeds which should have fostered your own? The employer at low wages in some coal, coke or iron region, of a sweltering, changing, overcrowded mass of ignorant and debased foreigners, who hang like some old man of the sea round the neck of our young American Sindbad? The typical middleman—not a necessary distributor of products, but an obstructor of the commercial channel—standing between the producer and consumer, and keeping them apart from, and ignorant of each other; one link of that chain which includes the general agent, the jobber, the wholesaler and the retailer? The engineer of a rapid transit road which transforms the old aristocratic precinct into a Mulberry Street slum and ruins an historic site to inflate a suburban lot? The consulting advisor of some hydraulic scheme which shall concentrate the forces of a cataract, and transform the waterfall's beauty into the dynamo's power? The utilizer of an ocean's flow who shall dam the Mull of Cantyre, and use the ebbing current of a sea to stay the ebbing current of a waning empire's commerce? The head of some great legal firm through whose ante-rooms of delay, through whose corridors of obstruction, through whose consulting chambers of technicality, through whose wickets of casuistry, bankrupt residue and dying legacy are relentlessly and finally absorbed? Or some great medical specialist plastering the open sore with a diagnosis and a five-syllabled Latin name, assuaging the anguish of a symptom by an explanation of its possible cause, tapping the pocket and lancing the purse, and mitigating tap and thrust by dilute hypodermic injections of that stimulating fluid, hope?

And will you at every office door hang out a placard in bold capitals which announces that you are an annual subscriber to the Charity Organization, to whom all applicants are respectfully referred? Or will you in some secluded valley hold with personal hand the cup of service to the individual lip? Will you rank yourself among those humbler beings whose little mill wheels are scattered like benedictions through the rural valleys of New England? Whose limited vineyards slope down to the quiet margins of New York's sweet, placid lakes? Whose apple blossoms cast a later snow shower on the smiling fields of Pennsylvania? Whose log cabins and slab huts, and pine shanties, and substantial farm houses, and trim villas, and picturesque cottages and Fifth Avenue palaces testify to the secretion from the floating elements of an abiding and permanent home?

"And is this all you have to tell us? Have you no special message?"

In that delicate and exquisite work, the "Religio Scriptoris" of Richard Le Gallienne, the author finishes by his answer to this ever-present cry for a special message. "Where," he asks, repeating the cry of others, "is the new prophet who will give peace to our souls? A very short time ago Browning's was the new message. Whitman's, Emerson's, Carlyle's, Ruskin's, Tennyson's. Was ever age more rich in prophets and great messages? . . . And yet, here we are hungry and clamoring again. The truth is that the men who cry out for new messages mean rather new sensations of doubt. It is not peace they want, but fresh perplexity. . . . . All the great men are of one mind. Their message is simple—so simple that we put it by. It seems so childish to our cultivated minds to say, Love God and love one another! Is that all? That have we known from our youth up. Yet is there nothing else to say." Here endeth the lesson of Richard Le Gallienne.

If, in the present case, special message there may be, it is no new one, but old and very simple. "Thou shalt love thy neighbor as thyself." "God setteth the solitary in families." From the fresh perplexity of an end-of-the-century modernity we call you back to the individual and family life. It seems so childish to do this! To abstract you from the intricate orbits of a world-wide commerce. To disentangle you from the twisted human skein—to unravel you from the social web—to rob you of these wondrous powers which abide in a great and far-reaching series of organizations—to set you apart as single factors in the mighty problem of a world's evolution. Yet there is a higher meed than public applause—it is the meed of self-approval. There is a sure way to produce a perfect whole, and that is by the supply of perfect parts. There is one method of organizing a conquering army, and that is by turning each soldier into a victor. There is one man it is your bounden duty to save, and that man is yourself!

But it is so simple to be only an honest business man, intent on giving every one his money's worth—only the head of a family—a mere center of cohesion—only a good citizen. Yes! But it is so great, likewise, to be the unquestioned master of one's own individuality—to be the ruling monarch of one's own privacy—to be one of that grand reserve, who, in times of emergency, let the routed and baffled columns slip between and behind them, while they stand impregnable—the advance guard—and to be, of this reserve, only a high private in the rear rank.

THE COMPOSITION AND CONSTITUTION OF CERTAIN ALLOYS.*

By Dr. C. R. ALDER WRIGHT, F.R.S.

FOR some years past the author has devoted a large amount of time to a laborious experimental inquiry into the subject of the relations of metals to one another as regards their mutual miscibility or solubility when rendered fluid by heat; many of the results obtained have from time to time been communicated to the Royal Society and abstracted from the proceedings of that society to the pages of this journal.* The present paper has for its object partly to collect together and to epitomize the general conclusions that may be drawn from these particular researches, so far as at present completed, and partly to discuss the subject in general; more especially since a good deal of confusion appears to exist in the minds of various writers between certain phenomena which, though allied, are really sharply distinguishable from one another; while a number of statements on the subject, repeated from text book to text book till fossilized, are in point of fact considerably inexact.

When two metals are melted separately and the one fluid poured into the other and the whole vigorously stirred, it sometimes happens that more or less complete solidification is brought about on account of chemical action taking place between the two, resulting in the formation of a definite atomic compound which is solid at the temperature of the crucible, and is not wholly dissolved in whatever excess of either constituent may happen to be present. This solidification, however, is comparatively of rare occurrence; in any case it can always be avoided by employing a temperature sufficiently high to keep the mass perfectly liquid, in which case one of two things happens: either the two metals intermix perfectly, mutually dissolving each other so as to form a single permanent homogeneous fluid that remains uniform in character so long as the temperature is maintained high enough to prevent incipient solidification; or they form two different liquids not miscible with one another, and separating from one another by gravitation on standing molten for a sufficiently long period; these fluids consisting respectively of the first metal containing in solution a saturating amount of the second, and vice versa. The two cases are precisely correlative with the behavior of alcohol and water when intermixed at the ordinary temperature, and that of ether and water employed in proportions not outside of certain limits, e. g., used in equal volumes.

In some cases the separation by gravitation only takes place slowly, notwithstanding that a notable difference in density may subsist between the two binary alloys formed; many hours, or even days, standing molten at an equable temperature may be requisite before approximately complete separation is effected, the two fluids forming a sort of emulsion, comparable with the minute oil globules suspended in milk, or with the persistent froth formed on shaking up ether with soap water or aqueous fluids containing various forms of organic matter. This circumstance has, in some instances, led to the erroneous belief that a given class of metals could be permanently mixed together in all proportions when molten, forming in all cases a homogeneous liquid, when in point of fact only metallic froths or milks are formed, consisting of two different intimately mixed alloys. In particular aluminum and bismuth and aluminum and cadmium have long been described as being freely miscible, whereas the contrary is the actual fact.

On the other hand, if a homogeneous fluid mixture of two metals be gradually cooled down, a point is sooner or later arrived at when solid matter begins to form. In some cases, and with certain proportions of the constituents of the mixture, the temperature at which solidification begins remains constant until the whole has solidified; this only happens when a definite compound of metals in atomic proportions is produced, no excess of either constituent being present. In general the temperature at which solidification commences is higher than that observed later on, when more solid matter has formed, especially toward the end of the operation, the portions last solidifying often requiring a considerable reduction in temperature before they become solid. The "incipient solidification point,"† or temperature at which solid matter first begins to form, is sometimes referred to as the "freezing point" of the mixture, but the term is an undesirable one in this connection, it being preferable to restrict the term "freezing point" to that definite fixed temperature (under constant conditions as to pressure) at which a single chemical substance (e. g., water, or a definite atomic compound of metals, e. g., SbAl) passes from the liquid to the solid state, this temperature remaining constant until the whole mass has solidified; whereas the "incipient solidifying point" refers to a variable temperature, viz., that observed at the earliest stage of the passage from the liquid to the solid condition of certain of the constituents of a fluid mixture, leaving still fluid a "mother liquor" of composition different from that of the solidified portion; this temperature being not only more or less markedly higher than the temperature of solidification of the last portions of the mass, but being also a value which varies even for the same constituents according to their relative proportions. Thus the beautiful experiments of Neville and Heycock (C.S.J. Trans., 1889, 666; 1890, 376; 1892, 888) have shown that when comparatively minute amounts of one metal are dissolved in a large quantity of another, the masses exhibit a series of incipient solidification points higher or lower than the true freezing point of the predominating metal by amounts closely proportionate to the weights of the other metal added; a rise being exhibited in those cases where the two metals are capable of combining chemically together,

* The last scientific paper prepared by the distinguished author, a short time before his decease. Read November 5, 1894, before the London section of the Society of Chemical Industry.—From the Journal of the Society.

* Wright and Thompson. Certain Ternary Alloys. Parts I and II. This Journal, 1890, 944-945.
C. R. A. Wright. Certain Aluminium Alloys. This Journal, 1892, 492-494.
Wright and Thompson; Wright, Thompson and Leon; C. R. A. Wright. Certain Ternary Alloys. Parts III, IV, V. This Journal, 1892, 245-246.
C. R. A. Wright. Certain Ternary Alloys. Part VI. This Journal, 1892, 695.
C. R. A. Wright. Certain Ternary Alloys. Part VII. This Journal, 1893, 449-450.
C. R. A. Wright. Certain Ternary Alloys. Part VIII. This Journal, 1894, 521.

† When a mixture of different substances in the fluid condition is slowly cooled, an immersed delicate thermometer indicates a gradually decreasing temperature until solid matter begins to form. At this point a slight rise in temperature is usually manifest on account of the mixture having become more or less superfused before the solid matter actually separated, the amount of this rise depending on the nature of the mixture, and also on the details of construction of the thermometer, its capacity for heat as compared with that of the mixture, and the amount of latent heat rendered sensible during the separation of solid matter. With a sufficiently large mass of material and proper arrangements to avoid too rapid chilling by radiation, etc., a practically constant temperature is thus indicated for some considerable period (often from 30 to 100 seconds, or even more), during which the loss of heat by conduction and radiation is balanced by the evolution of heat during solidification; after this the thermometer begins to fall again. The nearly constant temperature observed during this period is usually taken as the "incipient solidification point;" the method of observation has long been well known technically in connection with the valuation of tallow, etc., as "Dalican's process" (Mon. Sci., Paris, 1868).

forming compounds of higher melting point than that of the predominating metal (e. g., Sb dissolved in Bi or in Sn, or Ag dissolved in Cd); while in other cases a fall is observed from the magnitude of which conclusions may be drawn on Raoult's principle as to the molecular aggregation of the dissolved metal. Then the effect of adding a little zinc to a large mass of bismuth or lead is to produce a depression in the value of the incipient solidification point of the mixture below the fixed freezing point of pure lead (or bismuth) nearly proportionate to the quantity added, so that an "atomic fall" of about 1·5° in the first case and 5·0° in the second is observed: values comparable in magnitude and identical in sign with those observed when metals are employed miscible in all proportions with bismuth or lead, e. g., Cu, Ag, Sn, Cd, Au. Aluminum is so slightly soluble in molten bismuth, cadmium or lead, as to render it difficult to obtain any reliable measurements; but at any rate nothing abnormal is noticeable in its effect on these metals as compared with that in tin, with which it is miscible in all proportions when molten (Heycock and Neville, loc. cit. supra).

The phenomenon of segregation of solid matter from a liquid mass on cooling, such solid matter being different in composition from the portion still remaining liquid, is obviously wholly different from the phenomenon of want of miscibility between two different metallic fluids where no solid matter at all is present; but in many cases the distinction has not been appreciated by writers on the subject, and notable confusion and want of exactitude have accordingly resulted. As an example of this, even in so carefully revised a work as Morley and Muir's dictionary, now just published, this statement is made (article "Copper"), that "copper and lead melted together at a red heat form alloys; but the fused mass tends to separate into two layers, the upper containing much Cu and little Pb, and the lower much Pb and little Cu." On careful examination, however, this statement is found to be inexact; so long as the temperature is high enough to keep the whole mass fluid, the fused mass does not separate into two layers any more than does a mixture of alcohol and water; but at a somewhat lowered temperature solid matter begins to separate, rendering the mass more or less pastry; this solid matter is either copper alone or copper combined with but little lead, forming a difficultly fusible alloy, just as chilled alcohol and water will allow solid crystals to form, consisting either of ice alone or possibly of a cryohydrate of alcohol. In the case of copper and lead the solid matter thus separating floats up to the top of the remaining fluid matter in which the lead is concentrated; the degree of separation depends on the rate of cooling; but the tendency toward segregation is so marked that it is almost impossible to cool a mass of 30 or 40 grammes of mixed metals (in about equal proportions) without finding a measurable excess of copper in the top layers, and of lead in the bottom ones.

The preceding remarks respecting binary metallic mixtures for the most part equally apply to ternary and more complex alloys. These, when rendered completely fluid by heat, are divisible into two classes, viz., those which form single homogeneous liquids and those which do not, but give rise to two (or possibly more) liquids not miscible together inside of certain limiting proportions. When the temperature is reduced so that solidification commences, as a general rule segregation of constituents takes place, the portion first separating in the solid form having a composition different from that of the portion still remaining liquid.

The spontaneous separation from one another of the constituents of a fluid mixture of metals is obviously a matter of considerable importance in technical operations where alloys are employed for castings, or are prepared by fusing together the constituents; whether such separation be brought about in virtue of the immiscibility of certain metallic mixtures produced on melting together the constituents, or by segregation in the solid form of certain of the constituents or definite compounds thereof in the act of cooling, in either case a want of homogeneity in the cast mass is apt to be developed which may be of serious moment, especially in the case of ingots, etc., intended to be subsequently wrought by mechanical processes. As regards segregation during the act of solidification, it is well known that the larger the mass and the more slowly the cooling is conducted, in general the more likely is the segregating action to come measurably into play; and various devices are in use in foundries to minimize the action in different cases. But as regards the formation of immiscible alloys which separate from one another while still fluid, very little accurate knowledge of the limits within which such separative actions occur was extant at the time of the commencement of the author's experiments on the subject; the result of these researches, however, has been to define these limits with considerable precision in the case of a very considerable number of binary and ternary mixtures of the principal metals of ordinary occurrence. In order to distinguish from one another mixtures of metals which remain homogeneous while molten even on long standing, and mixtures which divide into two (or possibly more) different fluid alloys on standing molten for a sufficient time, the terms "real alloys" and "ideal alloys" may be conveniently applied to the two classes respectively, this nomenclature having been originally proposed by Sir G. G. Stokes* to distinguish from one another certain kinds of ternary metallic mixtures.

In order to examine thoroughly into the general question of mutual miscibility or otherwise of metals, and to decide how far the statements ordinarily found in the text books are correct or not, it was found necessary to examine in detail the behavior of each metallic combination separately. This is a somewhat greater task than at the first blush would appear to be the case; for even when the number of metals is limited to the following nine, the total number of possible combinations is a large one. Out of the nine metals Pb, Bi, Zn, Al, Sn, Ag, Cu, Cd, Sb, no less than 502 different alloys may be formed; by taking them two at a time, 36 combinations result; if three at a time, 84; if four at a time, 126; and so on, as indicated in the following table:

No. of constituent metals in mixture.	No. of combinations possible. Constituent metals miscible together in all proportions under all circumstances so long as temperature high enough to maintain perfect fluidity.	No. of combinations possible. Product divides into at least two immiscible alloys when constituents are in proportions inside of certain limits.	Total.
2	31	5	36
3	55	29	84
4	55	71	126
5	31	95	126
6	9	75	84
7	1	35	36
8	None	9	9
9	None	1	...
	182	320	501

In addition to the binary and ternary combinations of these nine metals (and some few more complex mixtures), various alloys have also been experimented with to some extent containing other metals, although their peculiar physical qualities more or less interfere with the systematic determination of limits of miscibility where fusion for lengthened periods is requisite; thus the volatility of mercury and arsenic prevents their convenient use at moderately elevated temperatures, while the high oxidizability of sodium and potassium renders special appliances necessary in their case. Again, the high fusing points of iron, nickel, platinum, and others, and the costliness of gold and of the rarer metals, prevent their being freely employed in the simple way practicable with the nine above mentioned. In several instances indications have been obtained that interesting results would follow the extension of the systematic experiments made so far, to include a larger number of metals.

BINARY ALLOYS.

On systematically examining the 36 pairs of metals obtainable from the above list of nine, from the point of view of forming "real" alloys only under all conditions, or of giving rise to "ideal" alloys when mixed in proportions inside of certain limits, and allowed to stand molten for a considerable length of time, it at once becomes manifest that in several instances the statements current in the text books are erroneous. For instance, it is ordinarily stated (apparently on the authority of Tissier) that fused antimony and aluminum will not intermix. This, however, is not the case; when fused aluminum and antimony are stirred together in certain proportions, a mixture of solid and fluid matter results; the former has been shown by the author to consist essentially of a difficultly fusible* compound of antimony and aluminum indicated by the formula SbAl; while the liquid part consists of a solution of this compound in whichever of the two constituents may be present in excess. If, however, the temperature be raised sufficiently high to render the mass fluid, a perfectly homogeneous liquid results which shows no tendency to separate into two different fluids, even on standing at rest molten upward of eight hours. Again, as above stated, copper and lead are described in various text books as not mixing together perfectly; but the fact is that so long as the mixture is kept hot enough to be perfectly fluid a single homogeneous liquid alloy is formed. Similar remarks apply to copper and bismuth. On the other hand, according to the text books, aluminum and bismuth unite together, forming useful alloys.

The following experiments may be quoted as examples illustrating the kind of figures obtained by operating in one or other of these ways, the alloys examined being accordingly regarded as not exhibiting the phenomenon of separation into two different binary mixtures of metals, while molten.†

Mixture of about one part zinc and two parts tin, kept fused for seven hours and cooled quickly.

	Zinc.	Tin.
Top layer of compound ingot.....	31·37	68·6
Bottom layer of compound ingot..	31·13	68·87
Difference ± 0·24		

Mixture of about equal weights of tin and cadmium, fused for six hours and quickly cooled.

	Tin.	Cadmium.
Top layer...	49·37	50·63
Bottom layer..	49·69	50·31
Difference ± 0·32.		

Mixture of about two parts cadmium and one of copper, fused six hours and quickly cooled.

	Cadmium.	Copper.
Top layer.....	66·20	33·80
Bottom layer.....	66·35	33·65
Difference ± 0·15.		

Mixture of about equal weights of bismuth and copper, fused four hours and sampled by "spoon and pipette."

	Bismuth.	Copper.
Top layer...	49·51	50·49
Bottom layer.....	49·76	50·24
Difference ± 0·25.		

In this instance, as in most others, the differences in composition between the top and bottom layers do not lie outside the limits of experimental error; in some few cases, however, indications were observed of a slight tendency for the lighter alloy to float up and the heavier to descend; thus, for example:

Mixture of about three parts tin to one of aluminum, fused six hours and quickly cooled.

	Aluminum.	Tin.
Top layer...	22·36	77·64
Bottom layer.....	21·39	78·61
Difference ± 0·97.		

Inasmuch as such differences between top and bottom were never great, and also varied from experiment to experiment, they were considered to be more probably due to incipient segregation during solidification than to the formation of true "ideal" alloys, incapable of permanent existence, and dividing into two entirely different real alloys.

Operating in one or other of the ways above described, the following 31 pairs of metals were ultimately found to produce "real" alloys, no matter what their relative proportions; i. e., no natural difference was discernible between the uppermost and lowest layers of the mass obtained by melting together, thoroughly intermixing by stirring, and allowing to remain at rest molten for some time (often several hours):

Aluminum antimony,	Bismuth tin,
" copper,	Cadmium copper,
" silver,	" lead,
" tin,	" silver,
" zinc,	" tin,
Antimony bismuth,	" zinc,
" cadmium,	Copper lead,
" copper,	" silver,
" lead,	" tin,
" silver,	" zinc,
" tin,	Lead silver,
" zinc,	" tin,
Bismuth cadmium,	Silver tin,
" copper,	" zinc,
" lead,	Tin zinc.
" silver,	

In several cases definite atomic compounds of the constituents of the above binary alloys appear to exist, so that when a molten mass containing the constituents in suitable proportions is allowed to cool slowly, the compound tends to separate from whatever excess of either constituent may be present. If the compound fuse at a higher temperature than the constituent present in excess (as, for example, the compound AlSb), the solid matter first separating consists of the compound, leaving as mother liquor a solution of the compound in excess of the more fusible constituent; if, on the other hand, the constituent present in excess have a higher melting point than the compound, this constituent separates first, the mother liquor consisting of the more fusible compound, together with more or less of the less fusible constituent dissolved therein.

On the other hand, the following five pairs* were found to yield only ideal alloys when mixed in proportions inside of the limits under mentioned:

Aluminum bismuth,
" cadmium,
" lead,
Bismuth zinc,
Lead zinc.

As the temperature rises, the limits between which ideal alloys are formed with these five pairs become narrowed; precisely the same thing is noticed with analogous ternary and more complex ideal alloys (vide infra).

LIMITS FOR ALUMINUM BISMUTH.

At near 870° C. between { Bi = 99·72, Al = 0·28 } and { Bi = 2·02, Al = 97·98 }

LIMITS FOR ALUMINUM CADMIUM.

At near 750° C. between { Cd = 99·78, Al = 0·22 } and { Cd = 3·39, Al = 96·61 }

(To be continued.)

FREE TRAVELING LIBRARIES.

By WILLIAM R. EASTMAN.

THE New York State traveling library system is a direct development of the work of the public library. The local library lends one book, the traveling library lends a hundred; the local library lends to a person, the other to a community; one lends for two weeks, the other for six months. In this way the State library becomes the parent of libraries.

This system was made possible by legislation of the State of New York in 1892. The University law of that

* Proc. Roy. Soc., 49, 380-91, 178.

* This Journal, 1892, 349. Prof. Roberts-Austen has subsequently determined the "solidifying point" of this compound by means of the Le Chatelier pyrometer, and found it to be practically identical with that of pure gold, 1,045° C., or upward of 360° C. higher than the melting point of the highest fusing constituent. So large a rise in fusing point is a phenomenon sui generis among compounds of metals with one another, although not unknown to a lesser extent; thus Roberts-Austen (see also this Journal, 1893, 840) has shown that aluminum and gold combine to form the compound Al_2Au, which solidifies at 1,065°–1,070° or upward of 30° above the solidifying point of the least fusible constituent.

The existence of the atomic compound SbAl has also been confirmed by D. A. Roche (Monit. Scient., 1893, 269; this Journal, 1893, 840).

† The percentages are calculated throughout on the sum of the weights of the two metals found by analysis as 100.

* The immiscibility of lead and zinc has long been known, notwithstanding that in certain books of reference they are still described as alloying "in all proportions" (e. g., Morley and Muir's dictionary, article "Lead Alloys," vol. iii., 125). More than thirty years ago their limits of mutual solubility were approximately determined by Matthiessen and v. Bose (Proc. Roy. Soc., XI., 430 [1861]; at the same time the corresponding limits for bismuth and zinc were also approximately deduced. Deville showed many years ago that aluminum and lead were immiscible. As previously stated, the immiscibility of aluminum and bismuth and of aluminum and cadmium was apparently unknown until recently pointed out by the author (Proc. Roy. Soc., 52, 19; this Journal, 1892, 492).

year authorized the Regents to lend for a limited time selections of books, from the duplicate department of the State library or from books specially given or bought for this purpose, to public libraries under State supervision, or to communities meeting required conditions. Out of $25,000 appropriated for free libraries, a portion was at once set apart by the Regents to buy and prepare books to be lent under their rules. The rules then adopted provide that a selection of one hundred books may be lent for six months to the trustees of any public library in the State under Regents' visitation, on payment of a fee of five dollars to cover the expense of cases, catalogues, record blanks, and transportation both ways. Where no such library exists, the books will be lent on petition of any twenty-five resident taxpayers. In their petition an owner of real estate must be named as trustee, who must be personally responsible for the books. Libraries may be lent to the officers of a university extension center, reading course, or study club, if registered by the Regents. A later rule offers selections of fifty volumes for a fee of three dollars.

It was decided to begin with ten libraries of a hundred volumes each. The libraries were chosen with reference to their educational value, without disregarding a reasonable demand for recreation. In these days, fortunately, science is becoming more and more capable of popular illustration, new books of history and travel have the fascination of romance, while fiction is burdened with the most serious problems of humanity; so that in making up a library the task of preserving an even balance between information and amusement is by no means difficult as it would have been twenty-five years ago. Books of reference and periodicals were ruled out, but a few bright sensible books for children were accepted. The tastes of professional men were not ignored; a few significant books on social science or economics were carefully sought. But all these were a small minority. After these, in order of importance, came books about the useful arts, about natural science, books of travel, biography, letters, history, and fiction, which were added in quantity and quality to suit the needs of "the general reader." It was obvious, too, that the requirements of different communities must greatly vary. There are some communities where even the old familiar books would be unknown; in others nothing but the latest would serve. To meet different needs, three libraries of the ten were made to include a liberal allowance of the older favorites, such as Scott, Thackeray, Dickens, Holmes, Prescott, and Parkman, which were excluded from the other seven; and one library was made up wholly of the books of the year 1892.

At length, after much revision and consultation at the State library, one thousand volumes were chosen and distributed into ten groups as nearly equal as possible in the range of subjects, in literary merit, and in attractiveness. The percentage of each kind of literature was: Fiction, 22 per cent.; history, 18; biography, 13; travel, 11; science and useful arts, 9; sociology, 5; religion and ethics, 4; fine arts, 3; other literature, 15.

Since the first ten lists were made up, later books have been constantly bought to supply additional libraries. The later libraries have been of fifty volumes instead of one hundred, to permit the more frequent appearance of a new library and a wider range of choice to the borrower, or the borrowing of a small library at less cost. The choice of books rests with the book board, made up of five members of the staff of the New York State Library.

In addition to the general libraries, special subject lists have been prepared; a set of fifty and a set of twenty-five volumes in each subject. Economics, agriculture, French history, and United States history, have been already taken up in these selections, besides lists in literature, to cover Regents' reading courses. The general lists now number eighteen; the special lists, nine. The university extension libraries also should be noticed. Any registered extension center may obtain one hundred dollars' worth of books for reference, selected by their lecturer, on the same terms as a traveling library. The same privilege is extended also to registered study clubs and reading circles. As fast as these books are returned, they are arranged as a distinct library to meet future requisitions.

The first purchase of books consisted of two sets of each of the ten general libraries. As the demand increased, other sets of the same were needed, and several have been duplicated ten times. Clothbound editions have been used. The price of single volumes has varied from forty cents to five dollars, list price. The average cost is a little less than one dollar a volume.

Books are made ready for circulation as in a well-equipped public library. The catalogue note on each book is intended to give in the briefest form a clear idea of its scope and character. Every copy of the printed catalogues contains the rules for local circulation, and these are supplied in quantity with each library sent out. A simple system of charging borrowed books is indicated in the rules, and book cards and readers' cards, specially designed for the purpose, are supplied. All cards are returned to Albany with the books, enabling the central office to keep full statistics of the use of each volume. An oak bookcase, with neatly paneled doors and a lock and key, is furnished with every fifty books. There is sent also a plain oak cabinet with a single drawer with compartments to hold cards, and the like. This outfit, with cards and packing cases, costs about fourteen dollars for every hundred volumes.

The first traveling library went out February 8, 1893. In eight months, up to October 1, 1893, 24 libraries had been sent out. In the second year, up to October 1, 1894, 101 had been sent; a total of 125. They went to 86 places. Of these 125, 43 were sent on petition; 40 to public libraries; 22 to academy libraries open to the public; 18 to university extension centers; 2 to individual borrowers. In all, 11,900 volumes were sent out, of which 9,600 were included in general libraries, 950 in subject libraries, and 1,350 in university extension libraries. Forty-four of these libraries, aggregating 4,400 volumes, are still out, leaving 7,500 volumes which have been returned without any loss or serious injury. One missing book, costing seventy cents, was paid for by a trustee.

Complete statistics of the circulation of 5,300 volumes are at hand. Their total circulation was 15,358, an average of 290 readers to each 100 volumes, in a period of six months. The smallest circulation was 66, the largest 609. One 50 volume library circulated 338. The number of borrowers was 4,392, showing an average of three and a half books to a reader. The details of circulation of the different libraries show great variation.

The library which had a circulation of 609 in one place had 186 in another; that which had 598 in one place had 122 elsewhere. The library that had but 66 in one place had 476 in another, showing that the circulation was determined by local conditions. Let us note a few examples. The library that reached the highest mark of 609 in six months was in the small village of Havana, in Schuyler County, where a library association had been organized by women a few years ago and had four or five hundred well-read books. But their books were growing old, subscribers were few, and they were at the point of discouragement when they petitioned for a traveling library and made their own library free. The next highest circulation—of 598—was reached in Ogdensburg, where a newly chartered public library of 3,000 volumes is under the care of the principal of the public schools, who, with his teachers, has guided an enthusiastic group of readers. Three successive libraries have gone to an academy in Canandaigua, and, under like active influences, have reached circulations of 339, 504 and 476. At Peru, a small station on the Au Sable Railroad where books were very scarce, a circulation of 490 was recorded, one reader taking 38. The lowest circulation of 66 was in a place where the demand was cut off by a prosperous library of 5,000 volumes. Nineteen places have already had two successive libraries, five places have had three, Fort Plain has had four and Plattsburg five. From this beginning Plattsburg has now a promising public library just chartered, whose trustees are preparing for use their first purchase of $400 worth of books. Six public libraries chartered within the year began by petitioning for traveling libraries.

Many interesting items might be gleaned from the record of individual books. For example, Mrs. Burnett's "Surly Tim" had fourteen readers in one place, and eleven, nine, three and two in others and none at all in another. "That Lass o' Lowrie's" was taken

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out by seventeen in one town and fifteen, four, two, six, and twelve in others. "Henry Esmond" was read ten times and "The Virginians" nine times in one place, and neither was called for in another. The circulation of fiction was 52 per cent. of all; but the books of fiction in the library were only 22 per cent.

In the department of travel the popular books are: "The West from a Car Window," 18 readers; "Boy Travelers in Africa," 16; "Tramp Across the Continent," 15; "On Canada's Frontier," 14; "Tenting on the Plains," 12; "Knockabout Club on the Spanish Main," 12. In popular science, only one goes above 11, and that is "Feathers, Furs and Fins," at 16 calls; "Electricity in Daily Life" has 10; "Horse Stories," 11.

Books on social science were usually read by two or three persons in a place. The highest records in this class are: "How the Other Half Lives," 8 readers; "Children of the Poor," 6; "Who Pays Your Taxes?" 6; "Girls and Women," 6. In biography, the favorites are: Butterworth's "Lincoln," 13 readers; Coffin's "Lincoln," 11; Holmes' "Ralph Waldo Emerson," 11; Hale's "New England Boyhood," 11; Schurz's "Lincoln," 10. Plainly, Lincoln is the hero. In other literature, "Over the Tea Cups" had 15 readers; "A Connecticut Yankee in King Arthur's Court," 13; "My Summer in a Garden," 10. In history the war stories are in the ascendant. Page's "Among the Camps" had 17 readers; "Boys of '61," 13; "Blue Jackets of '76," 11; "Battlefields and Victory," 10; "Battlefields of '61," 8.

A list of the neglected books is not without interest; but a large number of trials would be needed for a fair comparison. When library No. 10 had gone out and returned ten times, there was but one of its books unused in any place. That was Adams' "Three Episodes of Massachusetts History." This would not have occurred in ten Massachusetts towns. In the same library Merry's "Select Fragments of Roman Poetry," a book in Latin, had a reading in three different places. Keene's "Literature of France" was read in only one place, but by two readers. The number of neglected books is always reduced by further returns.

There is little to choose between the libraries in regard to popularity. The most popular has been the library which consists wholly of books published in 1892. But if the library that stands at the foot of the list in popularity had gone to the same places as the other libraries, I have no doubt it would have stood as high.

If, now, we turn to see how many books were taken by a single reader in six months, we find in one place—Peru—38 books charged to one name. At Harkness, the next station to Peru, a girl of thirteen took 32 books and a neighbor's boy of fifteen took 25. Other places show readers who handled 31, 27 and 24 books each. We cannot be sure that they read them, but it indicates at least the insatiable book hunger that prevails in some localities.

As a general indication of the appreciation with which the traveling libraries have been regarded by those who have used them, a few expressions are quoted from letters received:

"There was a great deal of interest in our last library, and I believe, when we get another, nearly all the books will be out at once."

"This is a country school district. Some of our people have never read books of any kind, and few have had the opportunity to read books like these."

"Interest is increasing. . . . Circulation has a steady growth."

"The circulation has greatly increased."

"We shall certainly get another next winter and every winter."

"The number of readers of our local library has increased tenfold."

"Increased interest in every direction. . . . It has led to the establishment of a reading room."

We may say that 25,000 books have been read as a result of these traveling libraries. They have been good books and have left their mark on a multitude of minds. These libraries have everywhere promoted an interest in good reading, and have already led to the establishment of some important local libraries. They have been cordially received and are more in demand now than ever before. As a public investment they have fully vindicated the wisdom of their projectors and have proved worthy of the continued interest of the State. The system admits, too, of indefinite enlargement. Special subject libraries may be multiplied as fast as they are wanted; and the addition of general libraries can keep pace with the publication of good books. The State of New York can well afford this offer of books to her citizens, which is at once generous and in the highest sense profitable; and the plan is confidently commended to the consideration of other States.—The Forum.

[FROM THE SEATTLE POST-INTELLIGENCER.]

A WINTER VISIT TO MOUNT RAINIER.*

MAJOR INGRAHAM'S STORY.

THIS expedition was undertaken to ascertain the cause of the apparent changes in the contour of the summit of Mount Rainier, as seen from Seattle, and to determine whether there had been any recent disturbances of a volcanic nature.

In spite of the great hardships and dangers incidental to such a trip, there were many persons who desired to be of the party. I selected Dr. L. M. Lessey, E. Coke Hill, George F. Russell, and R. H. Boyd companions for the trip. Mr. William M. Sheffield was selected by you as special representative of the Post-Intelligencer. I am satisfied a better selection could not have been made. Each performed his part bravely and proved himself worthy of my confidence. Without such hearty co-operation and obedience the trip would have been much less successful.

In arranging my commissary I provided for a trip of fifteen days, with supplies for twenty days in case of emergency. The greatest nutriment in smallest bulk was considered. Flour, rolled oats, coffee, condensed milk, cheese, seedless raisins, fresh beef, beans, salt pork, butter and sugar constituted the staples, about 225 pounds in all. The cooking outfit consisted of coffee pot, camp kettle and frying pan, with tin cups, tin plates, knives and forks for individual convenience. Our medicine chest contained whisky, Jamaica ginger, star pills, surgeon's plasters, etc. A spirit lamp with supply of alcohol was also taken. Green goggles, green veiling and a preparation of lamp black in tallow were taken to protect the face and eyes from the strong sunlight. Each individual provided himself with two extra suits of underwear, and the party was provided with oil suits, sleeping bags, etc. A tent and oiled canvas for a floor were taken along.

We left Seattle at noon, Monday, December 17. Our first stop was made at Puyallup. There we secured seven tried and true homing pigeons from Mr. Fred Meeker. These pigeons were to be the medium of communication from us to our anxious friends. Too much cannot be said of those trusty messengers. Messages were conveyed from the highest point in less than three hours.

At Wilkeson we secured pack horses to take our supplies to Carbon River, a distance of eleven miles. The packer refused to go further on account of the bad condition of the trail up the river.

We reached Carbon River at 2 P. M., December 18, and camped for the night. On the morning of the 19th the provisions, tent, guns, cameras, birds, etc., were apportioned as nearly equally as possible among the members of the party. Each man's pack, including his extra clothing and blankets, must have weighed at least seventy-five pounds. With light hearts and heavy packs we started up the river. For most of the distance our course lay along the bed of the river, but occasionally to avoid fording the main stream the trail changed to the woods skirting the banks.

At dark we found ourselves entangled in the underbrush near a branch of the river, tired, wet, and hungry, with no good camping place in sight. In desperation we plunged into the ice cold stream, and soon reached an island with a level place of sufficient size to suggest a bed for six. An ineffectual attempt was made to find wood for a fire. We pitched our tent, sought its shelter and the warmth of our sleeping bags for the night. It was unanimously agreed to call that place "Dismal Camp." At the first streak of dawn I ventured forth to find wood for a fire. A log of Alaska

* Continued from SUPPLEMENT, 998, page 15956.

cedar, cast upon the bank by high water, rewarded my search, and we soon had a fire to dry our clothing and boil our coffee.

TWO MEN TOOK A BATH.

Breakfast over, we began our third day's march. The mishaps of this day were numerous and interesting to the spectators. Russell took a header into the invigorating waters of the Carbon to recover a camera that had slipped from his grasp; Sheffield followed suit by taking an involuntary bath in the same stream, not forgetting to take second camera with him. It is hard to tell which suffered the more, the men or the cameras. On account of these involuntary baths, we concluded to make camp early, and when Sheffield, who was very anxious to keep up a lively pace, announced a cabin in sight, we at once made for its friendly shelter. This cabin is situated near the mouth of Canada Creek, from which some one has proposed that Tacoma shall bring her water supply. We spent a fairly comfortable night at this place, called "Miners' Camp."

Friday, the 21st, found us again fording branches of the Carbon, following blind trails or making new ones. There was considerable snow at this point, but not of sufficient depth to use our snow shoes. After several hours of hard work we decided to make camp and send a party foward to reconnoiter. Dr. Lessey and myself volunteered, and after a brisk walk of one and one-half hours, we came in sight of the much-wished-for Carbon glacier. Returning to our companions, we found them preparing to pass a comfortable night, tent pitched and fire burning brightly.

Saturday, the 22d, dawned upon us with a cloudy sky and soon the crystalline snow began to fall. Before starting out a snow shoe drill was ordered. It was entirely successful; after we had been on them for a half hour we felt that we were experts. The distance covered this day was not great, on account of having to ford the river several times and the great roughness of the river bed. It was quite dark before all the party reached our destination, "Camp Mountain View."

Sunday, the 23d, it was decided to make Camp Mountain View our base of supplies. Accordingly five days' rations, ten pounds apiece, were issued, and preparations made to ascend the glacier. Sunday was also stormy, and our progress up the glacier was much hindered thereby. At dark, after the hardest day of the trip, we made camp upon an island in the glacier. The snow was from eight to ten feet deep. By much hard work we excavated a cave in a steep bank of snow among a stunted growth of fir and hemlock. We succeeded in reaching the ground on the uphill side, and on the bare spot built a fire. This camp was called "Congo Shivers," after one of the party.

Monday morning, the 24th, dawned upon us bright and pleasant. The north side of the mountain, crowned by Liberty Cap and flanked by Observation Point on the right and Elysian Fields on the left, lay before our admiring gaze, apparently but a mile away. We were able to trace the paths of great avalanches down the mountain side to the glacier below. Walls of ice and snow hundreds of feet high, far up the mountain, showed where they had broken off. Great cracks in the snow showed where others were soon to start. In fact, while trying to sleep at Camp Congo Shivers, we heard the thunder of descending avalanches. Nearly the whole of the north side of the mountain is black and bare, all of this season's snow having slid down to the glacier below.

Upward over blind crevasses and ragged pinnacles of ice we pressed our way until the glacier became so broken and steep that further progress was impossible. We turned our faces shoreward, and after ascending a bank fully 500 feet high and nearly perpendicular, we found ourselves on the border of Elysian Fields, at the head of Pleasant Valley. It must be remembered that these names were given in the summer when this now ice-bound region was a mass of many-hued flowers. From this point our course lay southward across Elysian Fields, now up, now down. At times we had to take off our snow shoes and wallow up to our armpits in the snow up some steep spur, but the height gained was only temporary.

Our hunger, thirst, and fatigue were all forgotten in admiration of the scene around us. Distance was annihilated. Puget Sound and the Straits seemed to be at our feet, while the Olympic range stood out in bold relief from its southern limit to Cape Flattery. Northward and eastward we beheld the Cascades, the lesser peaks sinking into the great sea of hills, while Baker, Shuksan, Garfield, and the higher peaks flashed and glistened in the upper sky. The panorama of that day was worth the fatigue of the trip twice over. Later a warm spring, gushing from the hillside, but refusing the embraces of the ice king, gladdened our hearts and quenched our thirst.

After going about a mile further and rounding the foot of the great wall of rock dividing the Carbon from Winthrop glacier, I looked upward and beheld the eastern rim of the crater, bare in summer, but on this occasion covered with spotless snow. Curling slowly upward from within the rim of the great crater, I saw three jets of steam, white, against the cloudless sky. The sight was sudden and unexpected. Only on one other occasion had I seen jets of steam while on the mountain side. That was while I was making the ascent on the south side at a point much nearer the summit than on this occasion. Looking to the right in the direction of the smaller crater, I beheld what I have never seen before, either when upon the top of the mountain or climbing its sides—a column of dark smoke slowly ascending. I excitedly exclaimed to my companions: "See the smoke! See the steam!"

For full five minutes we gazed at the pearly white columns of steam on the left, and the ebony black column of smoke on the right. Our haste to push onward would not allow us to linger, so we soon lost sight of the crater by passing behind another spur.

Christmas eve was spent at an altitude of 7,500 feet, far above tree or shrub. Protected by a perpendicular wall of rock on one side, from which gushed a stream of water, having a temperature of 50° F., and a great bank of snow on the other, we dug a cave in the snow and lay down to rest. The sky was aglow with purple, green, and gold. Above a distant snow-capped mountain slowly rose Hesperus, the evening star. It took no great flight of fancy to see in her the counterpart of the star that rose above Bethlehem's hills 1900 years ago. Higher up the Pleiades glistened with light effulgent, and I imagined I saw the lost sister; belted Orion claimed our admiration, too, and the Dipper made full half the circuit of the heavens, with the "pointers" always true to the pole, before a roseate morn dimmed the resplendent scene. Our bodies gained no rest, but our souls gained an inspiration on that Christmas eve that will blend forever with our existence.

On Christmas morn we descended from our exalted camp to the Winthrop glacier. From the Winthrop glacier we had a clear view of the upper part of Blaine glacier to the summit. Much to my disappointment, I saw that the mountain at that point presented its usual broken surface. I had hoped that the deep snows had filled the crevasses so that an ascent on that side might be safely undertaken. It took us three hours to cross the glacier and climb St. Elmo's Pass. From the pass we obtained a view of Inter glacier and Blaine glacier. To the east and south, as far as the eye could see, a vast ocean of clouds covered everything except the summits of the highest peaks. The indications were that a great storm was approaching. Feeling that it would be foolhardy to go further, I reluctantly gave the word to turn back. Every member of the party would have continued the ascent under my leadership, but I felt the exposure and danger too great to ask men to follow.

In about six hours we covered the same ground that it took us two days and a half to pass over on our way up. We arrived at the foot of the glacier about 7 P. M.

Wednesday, Thursday, and Friday were spent in making our way back to Wilkeson without incident, and Saturday noon found us safely at home, much to our own pleasure and that of our friends.

E. S. INGRAHAM.

THE HOMING PIGEON.

ONE of the most important and interesting features of the recent Mount Rainier expedition was the sending of messages to the Post-Intelligencer by the seven homing pigeons taken by the party, by which the outside world was kept informed as to the movements and observations of the explorers. The birds, which have broken all records for flying from great altitudes, were owned by Fred S. Meeker, of Puyallup, who is the author of the following interesting article on the origin and uses of homing pigeons:

Homing pigeon is the accepted term now given to the pigeons used for flying journeys, whether or not they are also given messages to carry. It appears likely that the old carriers, dragoons and horsemen were thus used, but these being now developed into fancy breeds, independent of any such purpose, the term carrier only created confusion. For some time the names of Flying Antwerp or Antwerp carrier were used; but as the term Antwerp has gradually attached itself to the show variety developed from these birds, general consent has at length settled down to the name of homing pigeon, which exactly expresses what is meant. The fact is, the birds used in flying journeys are of no fixed type, and the extraordinary results attained of late years have been gotten by the fusion of different strains. At least three of these have been traced, one of them being the English dragoon; the second a really Belgian pigeon called the smearl, which, from the round head and occasional frill, was evidently of owl parentage; the third a round-headed, pearl-eyed, high-flying bird called the cumulet, and which was evidently related to the tumbler.

All pigeons are strongly attached to their homes, and will fly back to them as far as their powers allow. From time immemorial this tendency has been used to make the birds carry messages, as shown by Pliny and other classical authors; and it was early found that some strains, besides greater powers of flight, possessed greater intelligence, memory, power of observation, or other qualities which enabled them better than others to find their way home. These mental and bodily qualities admit of being cultivated, like any others; and the homing pigeon is a bird which, originally bred from various sources, has been perfected by simply breeding together the best performers, irrespective of shape or color. The types vary a great deal even now; some have long and thinnish beaks, some short and thick. All colors come from the same strain, and the owl blood now and then comes out in a frill on the breast. But all good fliers will be found to have a bold eye, a capacious forehead and powerful wings.

The longest flight ever made by a homing pigeon in this country, and as far as I am able to ascertain the longest in the world, was made by a bird on September 2, 1893, from Pensacola, Fla., to Fall River, Mass., the distance being 1,183 miles. Another most remarkable performance for long distance over a strange country is best told in a letter from John Shephard, of Philadelphia, as follows:

"The remarkable flight of N720, I think, is without a parallel in pigeon flying in America. He was sold from our coop on May 12, 1893, and was sent with twelve others to Green Bay, Wis., about 860 miles in an air line. Mr. J. M. Fraussens kept him a prisoner and bred seven youngsters from him. He then sold him to a Mr. Duchateau, who mated him and kept him until February 28, 1894. He than gave him his liberty. He was found the first week in March at his old coop in Philadelphia, mated to a tumbler hen. Being an N banded bird, no notice was taken of him, for we only flew our N banded birds 200 miles.

"A little circumstance occurred which caused me to hunt the bird up in our books. I then found he was sold to the gentleman in Green Bay. I then wrote to them asking them if they had lost any of the birds I had sent them; if so, to give me the number and sex and date when lost. In due time, on April 19, I received the information that Mr. Duchateau lost N720 on February 28. In the meantime he had been taken from the tumbler hen and was mated to a homer and sitting on eggs. As a young bird we flew him from the 200 mile station three times. That was the full extent of his flying. Every foot of the ground was strange and unknown to him. If you look at the map, you will see that Green Bay is on the lake 200 miles north of Chicago. If he had crossed the lake, he would have encountered other large bodies of water; therefore it is improbable that he did so.

"The course I think he took was: He skirted the lake shore to Chicago, then headed south, and lost no time in coming home, for when I saw the bird he did not look as though he had been with Coxey's crowd, but looked spruce and genteel. Strangely enough, his name was Dandy Jim. He is a very strong, powerful blue checker, full of determination and pluck."

Two of the most noted birds in the United States are now owned and bred by a Washington fancier. As in many other respects, Washington now leads in high class pigeons. One of these, called Gambrinus, is the champion of the world for speed in a long journey. This bird flew from Greer's Depot, S. C., a distance of 520 miles in an air line, in the remarkable time of nine hours and fifty minutes, making an average speed for the whole journey of over 1,525 yards per minute, and surpassing all previous records.

The other noted bird referred to is the king of all homing pigeons in the United States, a black checkered cock known as Rex. This bird is well named, for its most recent performance has indeed stamped him king of all homers. In 1890 he flew 600 miles over a southwest course. In 1891 he flew 500 miles. In 1892 he took part in the never-to-be-forgotten race for "The Item" 100 mile trophy, when a strong favorable wind met birds and phenomenal speed was made by the leaders. In this race Rex homed before the arrival of the watcher or timer, and when found in the loft was able to claim a speed of 1,668 yards per minute for the entire journey of 100 miles. He was then shipped to Chicago to take part in the race from the World's fair grounds, in which the best birds of the country took part, there being upward of 1,200 birds entered from the cities of Philadelphia, Newark, Brooklyn, New York, and Baltimore. Rex won this great race, which was under the World's fair management, with some time to spare, securing $50 cash prize, a gold medal and the first diploma. He was at this time owned by Fred Prinz, of Philadelphia, 660 miles from Chicago in an air line.

Much has been said and a great deal written about the speed, endurance and reliability of the homing pigeon as a carrier of messages both for business and pleasure; and this bird has demonstrated its usefulness in this respect. As a valuable adjunct in military operations their usefulness is undisputed. Their use for the rapid transmission of dispatches during the naval review of the past spring was widely published; but their most important achievement was in 1870, when they kept the outside world in touch with Paris, though all other means of sending communications to the besieged city were cut off or destroyed. Since then homing pigeons have not been ignored by any progressive military nation, and all the great European military powers have organized and perfected a pigeon service for the speedy conveyance of important intelligence. Even our own war department last June issued a circular requesting every breeder of homing pigeons in the United States to send to the department a list of the number of birds kept and locality of the loft, etc.

It has been a mooted question to what altitude a homing pigeon will fly, and various experiments have been made by taking pigeons up in balloon ascensions and liberating them at different heights as the balloon ascends. As a result of these experiments the statement has gone forth and is quite generally accepted as a fact that a pigeon cannot sustain itself nor will it attempt flight at a greater height than 300 rods (4,950 feet) from the surface of the earth. This has been disproved in more than one instance within the past six months by birds liberated on Mount Rainier. During the month of July, 1894, Major E. S. Ingraham took with him some homing pigeons on one of his exploring expeditions to this mountain, and at an altitude of 10,500 feet a bird was liberated. While the performance was not altogether satisfactory on this occasion, the bird sustained itself and flight was accomplished.

A more recent experiment, with results that speak for themselves, was accomplished by the party sent out by the Seattle Post-Intelligence runder Major E. S. Ingraham to investigate the reported volcanic eruptions that took place on Mount Rainier. This party took with them for the purpose of messenger carriers seven trusty homing pigeons. The most notable flight on this expedition was from an altitude on the side of Mount Rainier of 9,500 feet. From this great altitude the bird had no apparent difficulty in making its ascension and circles, which seem to be a necessary preliminary before determining its course and starting on the homeward journey. The message that this bird carried from an altitude of 9,500 feet was delivered at its home loft, some fifty miles distance from Mount Rainier, in but little over two hours after the message was written, and reported in the Post-Intelligencer the next morning, bringing the startling news that Mount Rainier was smoking and steaming. Thus it was proved by this flight that pigeons can make successful journeys from much greater altitudes than they are generally credited with. It is now the intention to continue the experiment with these birds from higher altitudes, and those persons in the best position to form an opinion say that they believe successful flights can be made from the very top of Mount Rainier, nearly 15,000 feet above the sea.—Seattle Post-Intelligencer.

[FROM POPULAR ASTRONOMY.]

THE STUDY OF PHYSICAL ASTRONOMY—SUGGESTIONS TO STUDENTS AND AMATEURS.

By T. J. J. SEE.

THE editor of Popular Astronomy has requested the writer to contribute something of interest to students and amateurs, and especially to point out some of the more difficult lines of astronomical research in which a beginner may reasonably aspire to work. As astronomy is by its nature an exact or mathematical science, some persons shrink from it in the belief that only the especially gifted can expect to achieve successful results. This common mistake has doubtless deterred many from accomplishing what was really within their power, if only they had been endowed with a sufficient faith in their own abilities and the

degree of perseverance which characterizes successful enterprises in other lines of human activity.

We might strengthen this proposition by the testimony of some of the most distinguished men who have labored in the cause of science, and could show that those who have made the greatest discoveries have claimed that they did so mainly by great industry and ceaseless perseverance.

Thus, it is related of Newton that when a friend asked him how he made his great discoveries, he replied, "Simply by constantly thinking about them;" the great philosopher being too modest to claim for himself anything more than the usual ability. Fourier in his eulogy on Laplace says: "His constancy has triumphed over all obstacles, . . . he has devoted his life to astronomy with a degree of perseverance of which the history of the sciences is perhaps without another example, . . . he would have completed the science of the skies, if it had been possible, . . . he has composed the Almagest of the eighteenth century." And one of the most illustrious of American astronomers recently said to the writer, in explanation of how his vast and splendid work had been accomplished at so early an age: "Well, I have been very industrious."

These modest claims for great men must not be construed to mean that great ability is not required for great discoveries, but that the ability of most persons, if fully developed, is much greater than is generally supposed.

What line of work, then, should a student in astronomy choose? Should he turn his attention to an easy subject and follow the rapid road to temporary success, or should he take a view which is more serious and more worthy of his exalted science, and plan for a profound study of the great law of gravitation and the mechanics of the heavens, which can alone make known the past and future states of the planetary system, at ages so remote that man has never witnessed and perhaps never can hope to witness the events predicted? Should he not desire to know something of the unfailing law of Newton by which we trace the planets through the ages and know with certainty what will be the celestial phenomena in distant centuries, even if the appearances can never be observed?

The majority of students are generally encouraged to take up some easy task, and accordingly of late years the subject of photography has been a great temptation to the student, the amateur, and to a large number of astronomers. It is hardly necessary to add that while amateur photography is a harmless amusement, it is not likely to lead to important scientific results. By this it is not meant to say that the wonderful development of photography is not worthy of study, and it is admitted that judicious applications of the camera for gathering facts of observation are of the highest importance: but it is maintained that the photograph can at best give only facts, and the explanation of the facts must always be sought in the fundamental laws of force and motion. Therefore the great powers of the photographic camera are only a means, and not an end; and to believe that photography can reveal other than facts of observation is to err seriously regarding the process of real scientific discovery. When the plates have recorded the appearance of the heavenly bodies, the material is at hand for a mathematical discussion of the results, which alone will be adequate to disclose the real laws and causes of the phenomena recorded. There is of course an artistic side to the question, and it might be maintained that photographs are inherently beautiful and therefore desirable; but if we regard the camera from the scientific point of view only, it cannot be denied that photography is only a means to the ends of science, which has for its object the explanation by known principles of the phenomena presented by the material universe. An amateur may ask: But has not astronomical photography, from some cause, made the impression upon the public mind that it is at once the object and the end of astronomical aspirations? If this is so, history will record it as one of the egregious errors of this age. For when we look at the matter in its true light we see that photography is simply a fine and very exact means of gathering facts, and that its delicacy is such that sometimes facts are discovered which are beyond the direct vision of the astronomer; and therefore photography has rendered great, and is capable of rendering still greater, services to the progress of observational astronomy.

In like manner, when the spectral lines of the stars have been recorded by the sensitive spectrograph, we have the material for an examination of the constitution of the fixed stars and their motions toward and from the earth. But we gain no real insight into the working of the universe without subjecting our material to a critical analysis. Therefore, although much excellent work has been accomplished in spectroscopy, and probable physical explanations of the phenomena revealed by the spectra of the fixed stars and nebulæ have been devised, our real knowledge of these phenomena is, we fear, not so great as is generally supposed. It is a somewhat discouraging circumstance that we find the spectrum of the same substance under different conditions is not infrequently entirely different, so that if we are ignorant of the conditions existing in space, we must remain somewhat doubtful as to the correct interpretation of the spectral phenomena of the heavenly bodies. Although the wave lengths of the principal nebular lines have been very carefully measured, and some of the nebulæ have been found to be moving in the line of sight with velocities which can be determined with a high degree of precision, we appear to be still in the dark as to the elements which give rise to the lines in question. The outlook is not improved by the fact that we are almost completely ignorant of the physical conditions existing in space, such as the temperature, the pressure, and the density of the nebulæ. Mathematical research might throw some light upon the constitution of these diffused masses, but without such analysis, observational astronomy will probably be powerless to effect any discovery of the laws of force and the properties of matter which prevail in those remote regions of the universe.

It is true, then, that photography and spectroscopy supply chiefly the material for astronomical work, and that no progress in physical astronomy can be made without applying a rigorous analysis to the results of observation. Therefore, we see that progress in physical astronomy—the astronomy which explains phenomena by their true mechanical causes—must be effected in our time by the same principles which guided Newton and Laplace, Adams and Leverrier. And it is not easy to see the scientific propriety or justice of names such as the "New Astronomy;" since while the so-called "New Astronomy" is occupied chiefly with gathering observational data, the explanation of these facts must be sought in the principles of the "Old Astronomy." And the two branches of modern astronomy must necessarily remain forever united, if true physical science shall continue to exist. The history of the ages shows that the one essential condition of true scientific progress is the constant treatment of observational material by mathematical theory; and when real physical laws have been thus discovered, they constitute the foundations of the great future developments of astronomical science.

As an example of this progress we may take the familiar case of the law of gravitation. The ancients observed the motions of the heavenly bodies with hardly less zeal than the moderns, but being ignorant of the physical laws of the celestial motions (knowing at best only the formal laws, the eccentrics, epicycles, etc.), the observed irregularities in these motions were utterly bewildering. In modern times, however, when Copernicus had established the true system of the world, and Kepler had discovered the laws of planetary motion, and Newton had discovered and applied the law of gravitation as a true physical cause, it was seen that the irregularities observed by the ancients (such as the regression of the moon's nodes, motion of the lunar perigee, the evection, precession of the equinoxes, etc.) are a necessary consequence of this great law of nature. The successors of Newton have been continually occupied with the development of the theory of gravity as applied in our system, but it is only since the time of Laplace that the law of gravitation has been used as a means of discovery as real as observation itself. Laplace and his successors during the present century have found that not only all the regular motions of the planets and the moon, but also all the (important) irregular motions follow from the law of gravitation, and constitute the strongest proof of its exactness, so that this law is now the basis of all exact work in physical astronomy.

It will be evident, on general principles, that good astronomical work in any line is always valuable and important; but we may point out that the astronomy of the United States can truly flourish only when all lines are developed, and especially the exact or mathematical branches on which the whole structure rests. While at present the scientific method is fully developed only in physical astronomy and practical astronomy, the other more recently developed branches of the science also will doubtless eventually be reduced to a mathematical basis. These remarks are not, however, to be construed as indicating that physical astronomy has been exhausted by the researches of the great mathematical astronomers of the last hundred years. On the contrary, only a good beginning has been made, and the demand is constantly arising for more exact determinations of the perturbations of the heavenly bodies, and new applications and developments of the theory of gravitation.

Orbits must be found for new comets and new asteroids and new satellites and new double stars, and this work is as important now as it was in the time of Laplace, Bessel, and Gauss. The time will never come when such work will cease to have a high value, since it is only by the finer determinations extended over long ages and to a variety of bodies that will enable us to detect the existence of any foreign cause, such as a resisting medium, working on the motions of the planets. It is only by such researches of the great astronomers of the past generation that we are enabled to say that the law of gravitation is exact to the highest degree, and that if any foreign causes are disturbing the motions of the planets, they must be very slight, and are hitherto insensible.

Some of our best universities now give encouragement to the profound study of astronomy, and hence the American student of average ability has an opportunity to enter upon these higher branches of the science, and has before him a boundless field of exploration.

Judging by the past history of exact science, it is not safe to predict that when the public sees more clearly the well known limitations to photography, which astronomers recognize as a means of gathering facts for astronomical theories, the great historic subject of physical astronomy will again take the place assigned to it by Newton and Laplace, Gauss and Hansen, Gylden and Tisserand? For since physical astronomy is at the basis of astronomical science, as long as exact science shall exist the subject of gravitation in its manifold workings must continue to engage the attention of astronomers.

It may not be out of place here to point out an error which pervades nearly all popular astronomical literature. It is commonly supposed that the discovery of Neptune from the perturbations of Uranus, by Adams and Leverrier, is the greatest achievement of modern astronomy; but this is far from being the case. Other discoveries have required greater originality and have been more important from the scientific point of view than even the discovery of Neptune. Laplace's discoveries of the causes of the long inequality in the mean motion of Jupiter and Saturn, and of the secular acceleration of the moon's mean motion, are both equal if not superior to Leverrier's work, and many other less conspicuous discoveries are, from a scientific point of view, of equally great importance.

Darwin's researches on the formation of the moon lead, in the opinion of competent critics, to far greater discoveries than that of Neptune; since if Neptune had not been found in this century it must have been detected at some later age by its perturbations on the motions of Uranus, which would have been periodic; while the cosmogonic history of the moon could never be inferred from any observed phenomena either in our own or in any future age.

It is only too evident that the popularity of a discovery is a very poor criterion for its scientific value. A new planet, a new asteroid, a new comet, appeals far more powerfully to the public imagination than the profoundest discovery in mathematical astronomy ever made by Newton, Laplace, or Hill. But will any one compare the two classes of discoveries? The illustrious example which has been set in this country by such astronomers as Bowditch and Peirce, Gould and Chandler, Newcomb and Hill, ought to be of service in the advancement of American astronomy. Yet it is undeniable that for some cause the study of physical astronomy has been much neglected of recent years.

Dr. Gould, in offering the Astronomical Journal prizes, recently said:

"There is perhaps no lack, in this country, of observers of comets, but it is unfortunately true that many of the observations have much less value than they would have if they were made more carefully and at judiciously chosen times. There is a notable lack, in this country, of mathematical investigators in astronomical lines. The great bulk of the work of definitive determination of orbits of comets and planets has been done in Germany and France. Two or three names only keep up our reputation in connection with the theories of the moon and earth."

The outlook for the future appears rather more hopeful, but it is evident that if the conditions of American astronomy are to be improved, those astronomers charged with the administration of prominent observatories and the professors of astronomy in our universities and colleges must make a more serious effort to educate astronomers.

By perseverance it is possible for an amateur to become a first-class observer (and great indeed is the honor which the writer would give to those astronomers who began as amateurs and who have rendered and are now rendering illustrious service to the cause of American science). But the amateur of the present day can also find facilities for the profound study of physical astronomy, and by steadfast effort will be enabled to render a higher and greater service to the science of his country. The serious student might therefore with advantage think of working on orbits and perturbations and attractions; and by aid of such treatises as Klinkerfues's Theoretische Astronomie, Watson's Theoretical Astronomy, Gauss' Theoria Motus, Oppolzer's Bahnbestimmung, Newton's Principia, Laplace's Mecanique Celeste, and Tisserand's Mecanique Celeste, he will be led into the most wonderful and the most interesting branch of astronomical science. The difficulty ordinarily encountered by a student is the mathematical one, but the writer believes that this is more easily overcome than is generally supposed. The suggestions embodied in this paper have been made with a view of pointing out certain lines in which a great service may be rendered to the future of American astronomy by those who are willing to spend time and energy in the sacred cause of science.

One thing cannot be emphasized too strongly, viz.: That the interests of American science demand that a greater number of students should devote themselves to physical astronomy, or celestial mechanics. Otherwise where will be the Bowditches and Peirces, the Goulds and Chandlers, the Newcombs and Hills, of the next generation?

The University of Chicago, January 7, 1895.

THE PRINCIPLES AND PRACTICE OF SADDLING.*

By M. J. TREACY, Veterinarian 8th U. S. Cavalry.

I HAVE no hesitation whatever in stating that the cause of sore backs is due to ignorance, which ignorance begets carelessness. Ignorance, inasmuch as it is impossible for any one who has not received instruction on this subject to fit, with success, a saddle to a horse's back. Carelessness, in as far as it is difficult to make people believe that sore backs are due to defective saddling, and that wounds arising from this source, no matter how slight, will never get well until the cause of the irritation is removed. Ignorance, in not regarding the horse's back as being composed of living, sensitive structures; carelessness, in subjecting it often for hours together to the continuous pressure of an unyielding saddle, and the weight of a tired soldier. Horses on the march require their backs, blankets and saddlery to be looked after each day, if they are to be kept in serviceable condition. How many are there in our cavalry service who know anything of this subject?

Before entering into a consideration of the fitting of the saddle, we must thoroughly understand the parts of this necessary equipment, as well as the structure upon which it rests. I therefore shall attempt to give you a brief outline of the anatomical formation of the horse's back, for until this is clearly comprehended, the work of "fitting" must be entirely empirical and haphazard.

The back has for its foundation a chain of bones, known as the dorsal vertebræ, each bone being connected with two ribs, one on each side, eighteen in number. Growing from the upper part are prominent bony processes known as the superior spines. These spines are of the greatest practical importance to us. They are of different lengths, for we notice that they increase greatly in height from the first to the fifth, those forming "the summit of the withers;" from the fifth to the thirteenth they rapidly decrease in size; from the thirteenth to the eighteenth they are almost uniform. We likewise notice they do not all assume the same direction, for from the first to the fifteenth they incline backward, the sixteenth is upright, the seventeenth and eighteenth incline forward; the fifteenth or sixteenth are said to be the keystone, or center of motion.

The ribs are eighteen in number, divided into eight true and ten false; the eight true ribs articulate with, or lean directly on, the sternum or breastbone, the ten false ones having an indirect attachment with the preceding rib. The case, formed by the backbone, breastbone and ribs, for the protection and accommodation of the heart and lungs, is very narrow in front and increases in width as we proceed backward. The anterior ribs are consequently straight, while the posterior are greatly arched. The ribs which concern us most just now, from the eighth to the eighteenth, present, at their upper surfaces, a flat part of variable width, called the "arch;" the eighth and ninth, for instance, have a flat upper surface of about two inches,

* A lecture delivered before the Fort Meade Lyceum.—From the Journal of the Military Service Institution.

the tenth to the fourteenth about four inches, the fifteenth to the eighteenth five inches. As soon as these level places are formed, the ribs curve downward to form the sides of the chest. On the width of those level surfaces depends the width of the back, and on those should rest indirectly the sideboards of the saddle. But if we depended on the flat upper surface of the eighth or ninth rib (the eighth is about two inches from the posterior edge of the scapula) to afford a sufficient bearing for the front of the saddle, it would not be enough, for as I have just shown, this surface is but two inches wide. Here we take advantage of those ribs being strong and firmly fixed to the sternum, or breastbone below, to impose weight upon their sides as well as arches.

The obliquity of the sideboards of the front of saddle is about forty-five degrees; and not only the sides, but the upper surfaces of the ribs, participate in this weight-bearing function, which from their strength and support below, they are well calculated to endure.

Here is a saddle, composed of two bridges and two lateral supports; the anterior bridge, or arch, is known as the "pommel," the posterior as the "cantle;" the lateral supports are called the "sideboards, right and left;" these should end at the pommel, for reasons which I shall explain. Here are the quarter straps, front and rear, the quarter strap rings, the cinch straps; here the sideboards should follow the exact slope of the ribs; here it should rest flat on the upper surface of the posterior ribs, for their sides, receiving no support from below (unlike the front ribs), cannot bear any weight except on their upper surfaces; they are also shorter and weaker.

In the front ribs, the weight is transmitted from above and also from the sides; in the false ones from above, only. Viewed superiorly, the back is narrow in front, broad behind, in shape somewhat triangular.

The transverse measurement of the body through the eighth rib is about seven inches, through the eighteenth, sixteen inches. The scapula, or shoulder bone, is flat and triangular, apex inferior, and placed opposite the first rib; its posterior upper surface coming as far back as the seventh rib, it is placed against the body in that peculiar direction, obliquing downward and forward, particularly in the well bred horse.

The body is slung betwixt the fore limbs. At every movement, the angle between the shoulder and arm opens and closes, and from the changes of its upper part follows:

1. As the limb is extended forward, the anterior angle of the scapula is raised upward and backward, the posterior depressed forward and downward.

2. The knee being fixed, and the foot being planted on the ground, the whole body passes over the limb, which, from inclining downward and forward when the foot first came in contact with the ground, gradually assumes the erect position. During the time the posterior angle of the scapula is ascending, and after the body has passed its center of gravity and the limb assumes the position of downward and backward, the ascent of its posterior angle continues until the final propulsion is given to the body, when the whole of the back portion of this bone turns outward, it, as it were, being pulled at this part from the ribs. This is the last act of propulsion.

I trust that I have said sufficient to show:

1. That locomotion requires a great variety of movements of the shoulder bone, as it almost describes a semicircle each time the body passes over the forelimb; the center of motion of this part being the shoulder.

2. That any interference with its movements must affect propulsion, owing to the angles formed by the bones being unable to open and close to the necessary degree; that it must also affect materially the safety of the horse and rider, to say nothing of the pain due to the pressure of a saddle tightly girted, together with the weight of a rider, not forgetting the great waste of muscular force required to overcome these obstructions.

What more ridiculous and pitiable sight can be witnessed than a troop horse with a saddle on its neck, tightly girted over his heart and lungs? Human athletes follow the Biblical teaching of "girding their loins" during their exertions, leaving the chest free and unconfined for their powerful respiratory efforts. Do we not endeavor to constrict these necessary movements when we cinch forward?

Can we wonder at horses getting tired, with heavy weights up, when they have an unyielding machine strapped on their shoulderblades, binding them down each side in a vise, preventing the free movement of the forelimb? Can we wonder, while horses are thus maltreated, at stiffened limbs, incurable lameness and injuries to men? And that on the march, daily reports of, "He can't keep up with the command," except by a sickly, bastard trot. Truly, horses' forelimbs are confined in a veritable strait-jacket under these conditions.

If these points are understood, and the front of our saddle be placed two inches from the posterior end of the shoulderblade, one of the chief secrets of good saddling is mastered, as we know the forelimb to be an active propeller, as well as weight bearer to the body.

When a man sits upright in his saddle, the fore limbs carry $\frac{4}{10}$ of his weight; when he leans forward, $\frac{6}{10}$; when he leans backward. $\frac{3}{10}$.

What does all this teach us?

1. Let nothing touch the shoulderblades.

2. Carry no equipments on the front of the saddle.

3. Get the soldiers to sit over the fourteenth dorsal vertebra, thereby saving the forelimbs from the unequal share of lameness, weight and concussion which now falls to them.

From the above statements, we are forced to the following conclusions:

1. That the shoulder must in nowise be interfered with or pressed upon, or its function is very seriously impaired. It must have free and uncontrolled play.

2. That the shape of the ribs prove where weight can best be supported. The large true rib, with its small upper surface, will stand pressure in a downward and outward direction, the false one, with its large upper surface, can bear weight in a downward direction only.

3. The bony processes growing from the upper surface of the spine are unfit to bear weight.

4. That any part of the back posterior to the ribs cannot bear weight; a, because there is no support below; b, the kidneys are immediately beneath the surface; c, the large propelling muscles of the body expand and contract here, causing a peculiar to and fro motion, which can be plainly felt by the hand placed on the loins; these will force the saddle forward and cause abrasions.

It is necessary to remember that no two horses' backs are alike, any more than men's feet are, and if our saddles are made according to regulation, horses backs are not. Some horses are high in the withers, some low, some short and broad, others long and thin; some with backs like a billiard table, others razor shaped; some running high behind, others straight; some with a dip like a valley, others with an arch like a bow. All these forms are met with and must be dealt with differently. But of all kinds of backs, let me warn you against that of the high withered horse with hollows behind his shoulder blade. This back cannot be made to stand active service for obvious reasons.

With our knowledge of the theoretical structure of the back, we can see how important it is that saddles should fit. This we can never accomplish, unless we carefully and systematically set to work to study the conformation of the animal we are about to saddle, and obtain with exactitude the size of the different parts of the back upon which the saddle rests.

Each English cavalry regiment is furnished with a fitting saddle, known as the "Wilkinson patent." It is simply a saddle hinged at the pommel and cantle, and graded so as to record the size and shape of the back. In fitting our saddle, it should be placed upon the bare back, the front of the sideboard should rest two inches below the shoulderblade. It must be wide enough to admit the blanket without pinching the sides of the withers, with at least two inches to spare at the top, and follow the exact contours of the ribs; at this part, remember, it must rest upon, and against them in front, as the saddle must get a hold here.

The sideboards must fit exactly the shape of the back; if too oval or convex, it will rock, if too concave, it only rests by its ends on the back, when these points will suffer. In front, the weight is transmitted downward and outward, behind, from above only.

The man is now placed in the saddle and these points again examined, the fingers being passed under the front and rear of the sideboards to see that those parts are clear as well as the tops.

Sore backs may be divided into three classes:

1. Injuries to the summit of the spines.

2. Injuries to the sides of withers.

3. Injuries to the weight-bearing surface of the back proper.

The first class—injuries to the top of withers—are produced through the pommel touching those points, from being too wide or the tree spreading. This must be remedied by a narrower saddle, or two blankets. There is no remedy for spreading.

The second class—injuries to side of withers—result from a narrow saddle, which rests vertically against those parts, instead of following their contour. The remedy is a wide tree or less blankets.

The third class—injuries to the back proper—chiefly occur over last rib, and are vulgarly known as "kidney sore." They occur on the nigh side from extra weight of carbine on off side.

Their causes are various:

1. When a saddle rests on the withers it is higher in front, the posterior ends of the sideboards are driven into the back by the weight of the man gravitating to the rear end of the saddle.

2. That vile seat known as the "barber chair seat" concentrates the man's weight behind, on the ends of the sideboards.

3. Sideboards being posterior to ribs, and lying on the enormous propelling muscles of the loins, these, by their powerful contractions, create wounds by friction against the rear ends of the sideboards.

Loss of flesh or "waste back," brings the weight nearer the bony column; starvation or hard work produces a loss of vitality of the skin, rendering it intolerant to pressure. This can only be remedied artificially by additional blankets.

Saddles suddenly removed from hot, sweat backs, cause rapid evaporation, producing tender skin, blisters, lumps and swellings. The blankets should always be surcingled on backs for an hour or two after removing saddles.

If our horses were kept in muscular condition by gentle walk exercise two hours daily, instead of being mud fat, equipments could be fitted to them before starting into active service, which would continue a reasonable fit. A fat horse must get rid of his surplus adipose tissue before he is of any practical use for service. We can learn a great deal from our experienced mule packers, who never remove their aparajos from their charges' backs for an hour or two after getting into camp.

On the march, men should have at least twenty minutes to saddle their horses and make their blankets and saddles a comfortable fit, as it is no easy matter to fit a full packed saddle against time, particularly on windy days. It is scarcely fair or just to saddle against time, and then punish the men for saddle sores; give them plenty of time to saddle first.

One frequent source of misery and injury to our horses is a continual chafing of the cinch strap against the ribs. This strap is clumsy, thick and too long. The soldier, to get rid of it, rolls it frequently through the quarter strap ring and cinch ring, causing a protuberance, which injures the horse's ribs and interferes with the man's knee grip.

As a substitute for the crupper and breastplate, I strongly recommend the surcingle, over seat of saddle and around the abdomen back of cinch.

Every cavalryman should know what measures to adopt in the event of his horse suffering from saddle injuries, how to recognize the cause, and what expedients to adopt to prevent its continuance, for until the cause is removed the effect will continue.

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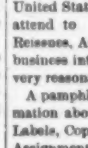

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